Force-Application Planning

A Systems-and-Effects-Based Approach

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Abstract

This study explores the following question: How can current force-application (FA) planning methodologies be changed or supplemented to provide better linkage between objectives, effects, and targets in order to achieve more effective applications of military force? The USAF has not articulated a clear theory of effects. Yet, in all FA analyses, planning, executions, and assessments, effects are used explicitly and implicitly. Due to this imprecise understanding of where effects fit into FA, the overall planning process for selective FA to achieve objectives suffers a like imprecision. Airpower's efficiency and effectiveness can be enhanced by a clear articulation of a systems-and-effects-based approach to FA that will supplement the existing planning frameworks.

There is a tension in the theory of operational art between established concepts based on a Newtonian framework and emerging concepts based on complexity theory. This study examines the implications of these frameworks for the nature of warfare and FA planning. At the heart of complexity theory is the concept of nonlinearity, which seems to embrace the dynamic nature of war better than traditional linear concepts. The implication of complexity theory for effects-based FA is that new opportunities may exist for the achievement of results (effects) out of proportion to the amount of force applied. This multiplication of force is achieved through leverage.

Airpower has historically relied on systems analysis as an aid to FA planning. Many airpower theories attempt to identify critical parts in a system which, when attacked, will affect the entire system. This search for "vital systems" and targeting rationales is explored in the works of Giulio Douhet, William "Billy" Mitchell, Sir John C. Slessor, the Air Corps Tactical School, and Col John A. Warden III, USAF, retired. An important aspect of target-and-effect pairings is an accompanying rationale that articulates how a particular pairing will affect an intended outcome. The concept of implicit and explicit rationales (which will be referred to later in this study as a *mechanism*) in the work of past FA theorists and current FA planners is important to this study.

The Joint Warfare Analysis Center (JWAC) provides FA planners with relevant systems analysis. Approaches and systems used by JWAC have historical antecedents in the work of past FA theorists. A systems approach to assessing an adversary is a valid framework for developing FA alternatives but should be supplemented with effects planning. Acting on a system must be linked to desired effects; and the effects must be connected to objectives, which validate the merit of the attack.

The intent of this study is to develop general propositions regarding the nature of FA effects. As part of that development, effect propositions are developed regarding time relationships, major functions of warfare, organizing schemes, levels of war, and simple and complex systems.

As one moves up the levels of war from tactical to strategic, the complexity of systems increases. This escalating complexity increases the unpredictability of effects at the higher levels of war. In turn this uncertainty leads to a need to

hedge and balance strategies, balancing those that rely on simple effects with those that rely on more complex effects. Annihilation and attrition (physical elimination) as strategies can be associated with the simple effects of destruction and elimination, while a strategy of virtual attrition (functional disablement) relies on more complex effects of functional disablement and system isolation and/or reduction. FA planners should consider both risk and payoff when choosing among strategies and effects schemes to accomplish objectives.

Second-order effects generated from first-order destruction are the primary tools of an effects-based approach to FA. Rather than targeting for destruction, FA planners should target for effects. The difference seems subtle but has a profound impact on keeping FA efforts focused on objectives rather than merely "servicing" targets. An effects-based approach does not supplant the need to develop targets. Instead, it shifts the focus to planning for effects before developing targets. This approach defines targets as means—rather than ends—to exert influence.

There is also a sound theoretical basis for a systems-and-effects-based approach that stresses coercive functional effects versus purely destructive effects. This approach emphasizes physical, systemic, and psychological effects as a primary means for influencing an opponent at the operational and strategic levels of war. Selective FA can induce effects that generate disproportionate impact within selected systems in order to fulfill linked objectives.

Because our analysis of an opponent's strategy is uncertain and problematic, effects-based FA is viewed better as an experiential and heuristic process than as a mechanistic and procedural one (more art than science). Closely coupled to a continuous assessment of the opponent's strategy is a need to develop effective means to assess how our coercive efforts are progressing. Without feedback that establishes the progress of our past and present efforts, it is difficult to regulate future efforts.

The attendant uncertainty concerning an adversary's motivation and behavior dictates that our actions to influence his or her behavior be framed in terms of probabilities rather than certainties. A hallmark of a nonlinear approach to warfare is to frame FA potentials in terms of trends and probabilities instead of certainties. A strategy of coercive FA, when confronted by competing beliefs and probabilities regarding an adversary, should do what all wise strategies have done before—hedge. It should hedge using both a pragmatic strategy that focuses on attrition (brute reduction) and a more idealistic strategy that concentrates on virtual attrition (functional reduction).

About the Author

Maj Jay M. Kreighbaum, a command navigator with more than 2,400 flying hours, is currently assigned to the Air Staff, where he works in AF/XOXS (Skunks). He was commissioned in 1982 through the Reserve Officer Training Corps, North Texas University. A distinguished graduate of undergraduate navigator training in 1983, he went on to fly the RF-4C as a weapon systems operator (WSO) and instructor WSO at Zweibrücken AB, Germany, from 1984 to 1989. Returning to the United States in 1989, he served a tour with the 16th Tactical Reconnaissance Squadron at Shaw AFB, South Carolina, before the unit's deactivation. In the fall of 1989, Major Kreighbaum transitioned to the F-15E and was directed to the 336th Fighter Squadron at Seymour Johnson AFB, North Carolina. He deployed and flew with his unit during Operations Desert Shield, Desert Storm, and Southern Watch. In July 1994, following 12 years of operational flying, he was assigned to Air Combat Command in the Requirements Directorate, Force Application Division, as the Joint Direct Attack Munition action officer. In 1996 Major Kreighbaum attended Air Command and Staff College and received the commandant's award for research excellence. He has a bachelor of fine arts degree from North Texas University and a master's degree in science and administration from Central Michigan University. He is a 1998 graduate of the School of Advanced Airpower Studies (SAAS), now the School of Advanced Air and Space Studies (SAASS), Maxwell AFB, Alabama. Following SAAS, Major Kreighbaum was assigned to US European Command (EUCOM), where he worked theater engagement planning in the J-5 Strategy Division and was promoted to lieutenant colonel. Subsequent to EUCOM and immediately preceding his current position, he attended the Army War College at Carlisle Barracks, Pennsylvania.

Acknowledgments

I acknowledge Prof. Karl P. Mueller for pointing me in the direction of several valuable works that were instrumental in the development of this study. I also thank Dr. Mueller and Dr. Harold R. Winton for their patience, effort, and direction in reviewing and guiding this long study. Most importantly, I express my sincere appreciation to my wife, Jeanne, and our two children—Brysen and Juliana—for their love, patience, and understanding during the many hours that were necessary to leave me to my work.

Chapter 1

Introduction

> *Objectives are essential to achieve unity of effort. In the abstract sense, the objective is the effect desired. In the concrete sense, the objective may be a physical object of the action taken, e.g., a definite tactical feature or asset, the seizure, damage, destruction, or holding of an objective that is essential to the commander's plan. This is more accurately termed the "physical objective." The physical objective must not be confused with the aim, or military end state, although occasionally they may overlap.*
>
> —Joint Publication 0-2
> *Unified Action Armed Forces*

This study considers objectives in both the abstract and concrete senses mentioned above. Rather than looking at targets first and taking whatever effects are generated from the targets, force-application (FA) planners should ask, "What effects can be planned that will contribute to the fulfillment of an objective?" When the effects are established, the planning can then move to determining against what objects (targets) force should be applied to produce the desired effects. If the analysis has been sound, generation of the desired effects should facilitate accomplishment of the objective.

At the very heart of FA are underlying beliefs about cause-and-effect relationships, such as "striking this target will produce this effect." The implicit belief that underpins a target-effect pairing has a rationale associated with it. This rationale establishes the reason that a particular target-effect pairing will ultimately translate to influencing an associated objective. This belief or logic of causality that links a target with effects, coupled with the rationale supporting this logic, is collectively known as a mechanism. The exploration of target-and-effect pairings, the nature of effects, and an inquiry into mechanisms are key elements of this study, which explores the following question: How can current FA planning methodologies be changed or supplemented to provide better linkage among objectives, effects, and targets in order to achieve more effective applications of military force?

Because this study concentrates on FA planning rather than execution, the traditional convention of illustrating FA execution in a left-to-right sequence will be replaced by a convention that places FA planning in this sequence instead of execution. FA execution will be depicted as flowing in the opposite direction of right to left (fig. 1).

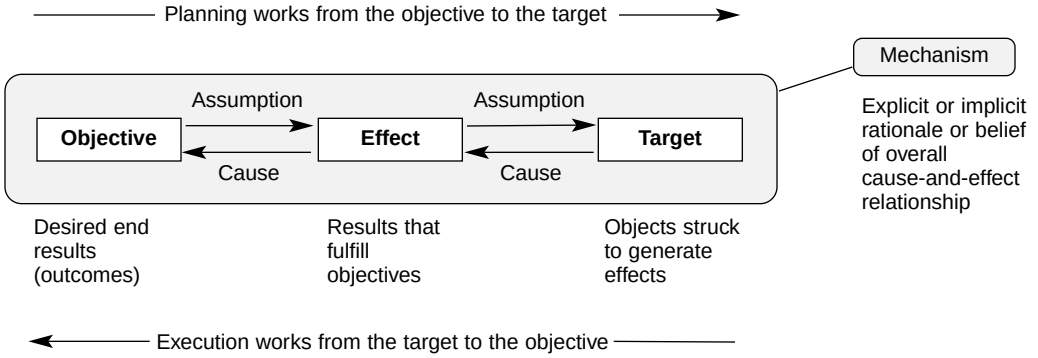


Figure 1. Objectives-Based Approach

Background and Significance

Rather than concentrating on targets, FA planning should focus on effects.[1] Essentially, we (FA planners) have it backwards. We must shift from input-driven targeting to output-driven targeting, moving from a mentality of servicing targets to one of producing effects that accomplish objectives.[2] The current FA-planning mind-set consists of selecting a target and accepting whatever effects follow from its destruction. This study argues that FA planners should first select an effect that relates to the objective and then determine what target can be associated with achieving that effect (as shown in fig. 1). This determination of effect-to-target pairing employs the concept of invoking an appropriate mechanism. In planning, one begins with the objective desired (outcome) and works through intermediate effects to identify targets that—if struck—will produce the desired effects.[3]

Closely associated with the failure to plan from objectives to effects to targets is an overemphasis on targeting for destruction versus targeting for effect. This focus on targets rather than effects tends to reduce the principal outcome of FA to destruction rather than influence. This study proposes an alternative focus on effects that should provide FA with enhanced possibilities for influence and persuasion.[4] It also argues that destruction is the root effect of FA, not only for the limited goal of physical removal but—more importantly—for what it sets in motion, its downstream results (second-order and higher-order effects), and their subsequent accretion to objectives. For example, FA should focus on destruction as a means to effects and not on destruction of targets as an end in itself.[5]

Because the nature of second-order and higher-order effects is not well understood, there is a tendency to focus solely on first-order effects. This reflects a natural pragmatism that one would expect from the military application of power. This study proposes that inefficiencies and diseconomies in efforts occur due to this myopia. There is a natural propensity to

bomb for material effects due to their more objective and measurable nature over nonmaterial effects associated with morale, will, and systemic effects (with their indeterminate qualitative natures).[6] Problems associated with measuring nonmaterial effects lead to their being dismissed in favor of more measurable efforts and outcomes.[7] Underlying this tendency is a general inclination for the military to favor the quantitative over the qualitative, the tangible over the intangible, and war-making over war-sustaining and war-will-associated targets.[8] In fact, this propensity can be stated as a maxim: The more indirect a desired effect (second order) is from the destruction (first-order effect) of a physical object, the more abstract that effect becomes. The validity of the maxim describes an increased difficulty in the measurement of effects, which in turn leads to a tendency to discount the effect as not being worth the effort. This phenomenon explains in part why enemy military forces are so often chosen as targets: It is because the effects produced by destruction of these targets are easier to assess than are the indirect effects produced as a result of first-order destruction. However, this study argues that an overreliance on first-order effects is not necessarily the most efficient or effective means to achieve objectives within the totality of FA efforts.

Methodology: General FA versus Airpower-Specific FA

The intent of this study is to examine FA planning from the standpoint of the joint planner and strategist. Although the concepts of FA planning addressed in this study are primarily derived from airpower uses, they should have application to other forms of military FA planning as well.

Military FA is a subset of the general use of military force; in turn, the various forms of military power (land, sea, air, space, and amphibious) are subsets of FA.[9] This study also argues that by thinking in terms of effects, one can cross service lines (mediums and domains) and focus not on who or what induced the action but on the *deliverable itself,* the effect of the FA. The point of an effects-based approach to FA planning is to reframe the planning dialogue in terms of targets and effects and place effects ahead of targets in the framework. This positional change in the planning sequence should establish effects to achieve objectives as the primary focus of planning.

In a joint context, a strategy based on effects represents an attempt to find an unequivocal and compelling metric that can be used to make arguments over weight of effort in strategic planning, force structure, and budgets.[10] The aim is to make effects the equivalent in the business world of profit and market share, an indisputable rationale for efficacy of effort. Effects-based strategy represents an attempt to put issues and choices in terms of the capability either to produce or not produce the desired effect and thereby contribute to the fulfillment of an objective.

Overview of the Argument

Airpower is continuing to evolve in the context of operational art. Many old and emerging ideas and developments seem to be converging to shape airpower's contribution to operational art.[11] Chapter 2 establishes the principal terms and definitions of operational art that are used throughout the study. The definitions are essential to establish the frame of reference for the subsequent analysis.

Chapter 3 develops the thesis that the Air Force has had essentially a reductionist approach for years, which demonstrates that the USAF follows a target-based and systems approach to FA. It also explores the historical genesis of this approach. The "systems approach catechism" is articulated and supplemented by Mancur Olson's ideas on the attack of economic systems. The intent of developing this notion of a systems approach is twofold: first, to expose it; and second, to establish it as a framework to be supplemented by an effects-based approach.[12]

Chapter 4 establishes the applicability of effects to FA and sets forth both abstract and general propositions regarding effects. This portion relies heavily on a recent work in this area by Robert Jervis.[13] Chapter 5 continues the development of an effects-based theory, focusing on a concrete sense of effects. An important part of this argument is coupling effects to the strategic, operational, and tactical levels of war.

Chapter 6 examines several key theorists' thoughts on effects and effect-target pairings. The contribution of this section establishes a historical basis for effects and a synthesis of the theorists' ideas on pairings. It specifically focuses on the mechanisms implied in the linkages of targets, effects, and objectives.

Chapter 7 proposes an expanded theory of coercive FA that places the effects-based methodology of FA in a larger conceptual construct. This portion of the argument is pivotal because it develops the idea of influence versus destruction in regard to FA. It also argues that FA and airpower planning are best served by an iterative (due to a thinking and reacting enemy) and experiential approach (due to lack of certainty and feedback concerning effects). The chapter further reveals that a logical inconsistency exists among paradigms about coercive FA, which is at the root of inefficiencies in FA.[14]

Chapter 8 outlines a framework for a systems-and-effects-based approach to FA that has the potential to enhance significantly the planning and conduct of operational art. Finally, the conclusions and implications of this study are detailed in chapter 9.

This overview of the argument indicates that this study is largely conceptual. Therefore, the primary body of thought is drawn from concepts and theories related to FA planning, operational art, complexity theory and nonlinearity, systems analysis, system effects, and airpower theory. However, where necessary, the concepts have been supported with examples from World War II, Operation Desert Storm, observations from a Twelfth

Air Force operational-planning exercise, and other operationally relevant experiences.

Notes

1. Steven M. Rinaldi, *Beyond the Industrial Web: Economic Synergies and Targeting Methodologies* (Maxwell AFB, Ala.: Air University Press), 1995. Rinaldi develops the concept of an output (objective)-based target process. Rinaldi's objective-based approach starts with the commander's intent and theater objectives then works through what [effects and] targets will contribute to the fulfillment of the selected objectives. Since this concept has taken root in air-campaign planning, mostly facilitated by the strategies-to-task methodology, I can be rightly accused of "piling on."

2. David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995), 10. Colonel Deptula develops a number of key concepts that support my thesis. Principal among them are an effects-based approach that is closely linked to the level of war one plans on affecting and the idea of destruction to generate effects in order to influence and compel a result.

3. Thomas P. Ehrhard, *Making the Connection: An Air Strategy Analysis Framework* (Maxwell AFB, Ala.: Air University Press, 1996), chap. 2; and James G. March, *A Primer on Decision Making: How Decisions Happen* (New York: Free Press, 1994), 12–13. Working backward is a form of decomposition. "Working backward encourages a perspective in which decision-makers decide what they want to have happen and try to make it happen." Ehrhard develops his own framework for airpower planning and employment that gives a great deal of thought to the development of the concept of a mechanism. His mechanism links airpower actions to political outcomes and is essentially an argument for a specific cause-and-effect relationship. Another important development of his work is the distinction between the air-campaign-planning process and the execution process. A planner moves in Ehrhard's framework from left to right, from political outcomes to mechanisms to airpower actions, while the execution aspect moves in the opposite direction from actions to outcomes.

4. The idea of airpower as a coercive instrument of power for compellence versus brute force will be more fully developed in chap. 7, along with its theoretical underpinnings.

5. Deptula, 4.

6. Daniel Gouré and Stephen A. Cambone, "The Coming of Age of Air and Space Power," in *Air and Space Power in the New Millennium*, ed. Daniel Gouré and Christopher M. Szara (Washington, D.C.: Center for Strategic and International Studies, 1997), 43. The authors discuss the need to develop new measures of effectiveness beyond simply counting targets struck and destroyed and ordnance delivered. They point to a need to develop a means to measure our ability to affect an adversary's behavior and strategy as well as our control over the opponent. By inductive reasoning then, if we need to develop these measurements, we also need to develop the FA and effects to precede them.

7. John A. Warden III, *The Air Campaign: Planning for Combat* (Washington, D.C.: Pergamon–Brassey's, 1989), 42.

8. Barry D. Watts, *The Foundations of US Air Doctrine: The Problem of Friction in War* (Maxwell AFB, Ala.: Air University Press, 1984), 106–12.

9. Including the Marines as a power unto themselves is absolutely intentional. In truth, they prefer this interpretation of themselves as an indivisible power; and in this study at least, I readily grant it. I have left out the special operations forces; but they, like the Marines, show strong tendencies to best be considered as a separate and distinct power.

10. Deptula, 17; and Rebecca Grant, ed., *Origins of the Deep* Attack *Weapons Mix Study* (Arlington, Va.: IRIS Independent Research, 1997), 5.

11. A selective inventory of the converging ideas and developments follows. Some of the leading ideas are David Deptula's work on the primacy of planning for effects, the levels of

war, and parallel attack; Steven Rinaldi's work on output (objective)-based targeting; and Robert Jervis's ideas on generating a theory of effects and their applications in political science. Rebecca Grant's inquiry into the need for the Air Force to establish formal doctrine at the operational level and a call for an effects-based exposition on airpower are also included. The new draft of Air Force Doctrine Document 2-1.2, "Strategic Attack," which lays down much of the conceptual framework for effects-based thinking to the application of strategic air attack, is also considered. The emerging trends are those of stealth and precision weapons and precision intelligence, possibilities for information warfare, and other potentially nonlethal methodologies for manipulating and compelling an opponent.

12. James N. Rosenau and Mary Durfee, *Thinking Theory Thoroughly: Coherent Approaches to an Incoherent World* (Boulder, Colo.: Westview Press, 1995), chap. 8.

13. Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, N.J.: Princeton University Press, 1997).

14. A preview of this argument is that FA essentially aims at changing a state's behavior through compellence. On the other hand, FA acts upon an opponent principally by modifying material within the target state. That modification of material is almost exclusively destruction. Taken together, these two paradigms state that FA seeks to compel an enemy state to modify its behavior by modifying its material. What is not well understood or well developed is the linkage between material modification and behavioral modification. An underlying implication of this lack of understanding is that progress in linking the two may well come from psychology and sociology, the soft sciences (behavior) rather than the hard sciences (material). The soft sciences and behavior modification are not well represented at the Joint Warfare Analysis Center, the principal defense-targeting-analysis (science) organization.

Chapter 2

Concepts and Terms

> Operational art—*The employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art translates the joint force commander's strategy into operational design, and, ultimately, tactical action, by integrating the key activities at all levels of war.*
>
> —Joint Publication 1-02
> *Department of Defense Dictionary of Military and Associated Terms*

In developing an effects-based approach to FA, one must define and develop some key terms that make up the conceptual landscape of operational art.[1] One key concept implicit in the above definition of operational art is the idea that *coherent* force application takes place through strategy (ways) by *linking* objectives (ends) to targets (means) at all levels of war.[2] An intermediate concept that links objectives and targets is effects. In this sense, operational art is the art of creating coherent linkages between political and military objectives.

Force-Application Planning

Over time, many concepts have developed to explain campaign planning. This chapter considers the following established terms: *center of gravity* (COG), *criticality* and *vulnerability*, *leverage, direct* and *indirect approaches, nodal analysis, target, strategies-to-task methodology,* and the *levels of war.* Additionally, less well-defined and emerging terms are discussed and developed, including effects, mechanism, linear and nonlinear systems, tight and loose coupling, and complexity theory.

Established Concepts

Most of the terms in this section are established in both service and joint literature. However, interpretations of them vary; and in the context of developing an effects-based framework, their meaning requires clarification.

Centers of Gravity

According to Joint Publication (JP) 3-0, *Doctrine for Joint Operations,* "The essence of operational art lies in being able to *mass effects* against the enemy's sources of power in order to destroy or neutralize them. In theory, destruction or neutralization of enemy centers of gravity is the most direct path to victory" (emphasis added).[3] In this study, *massing*

effects assumes, first, that effects are cumulative; and, second, that effects at all levels of war contribute to defeating an opponent.

COGs are analytical tools for focusing strategy and FA. Steven Metz and Frederick M. Downey have developed a useful scheme for conceptualizing COGs.[4] Their framework organizes COGs into the strategic and operational levels of war. It further differentiates COGs at the strategic level of war into two variants (see table 1). The principal insight derived from this framework is its organization of COGs along the levels of war. Moreover, an additional insight is the description of COG *tangibility,* ranging from the concrete (war making/enemy forces) to war sustaining (lines of communication [LOC] and war industry) to the more abstract, war will (psychological factors).

Table 1

Centers-of-Gravity Framework

Strategic Level	
War Sustainment	*War Will*
Variation A: Infrastructure and interdiction (concrete)	Variation B: Will (abstract)
Factors other than military forces Tangible elements such as lines of communication and war industry	Psychological factors Intangible elements, anything vital to the enemy's will to resist and which can be destroyed or eroded
Operational Level	
War Making	
"That characteristic, capability, or locality from which a military force derives its freedom of action, physical strength, or will to fight." (Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms,* 23 March 1994)	

JP 3-0 offers another concept that requires integration into this study's notion of COGs.[5] This involves an FA planner's choice of focusing on forces, functions, or both. In the context of the COG framework, this choice represents a direct approach against enemy forces primarily at the operational level of war or an indirect approach against enemy sustainment and will (functions) at the strategic level of war.[6]

Critical to understanding an effects-based strategy for FA is appreciating that there has been a tendency for a kind of default pragmatism that focuses exclusively on the operational level of war and an opponent's forces.[7] This occurs because as a planner moves from considering effects against an enemy's war making, to its war sustainment, to its war will, the relative level of abstraction and complexity increases.[8] Additionally, physical objects become harder to associate with desired effects and objectives as one moves from the tangible to the intangible.

COGs are centers of enemy resistance that encompass both hostile ability and hostile will.[9] The concepts of hostile ability and hostile will are interrelated and interactive (i.e., one usually cannot affect one of them

without affecting the other). COGs are dynamic and require frequent assessments to justify their value for future FA efforts.[10]

Criticality and Vulnerability

The ideas expressed in this section of the study are derived from three principal sources.[11] Criticality refers to the *potential value* of affecting a given system, and vulnerability refers to the *susceptibility* of a system to FA.[12] The interrelated nature of criticality and *overall* vulnerability are outlined in figure 2. It does not benefit an FA planner to consider the value of a COG in isolation from the susceptibility of the COG to FA.

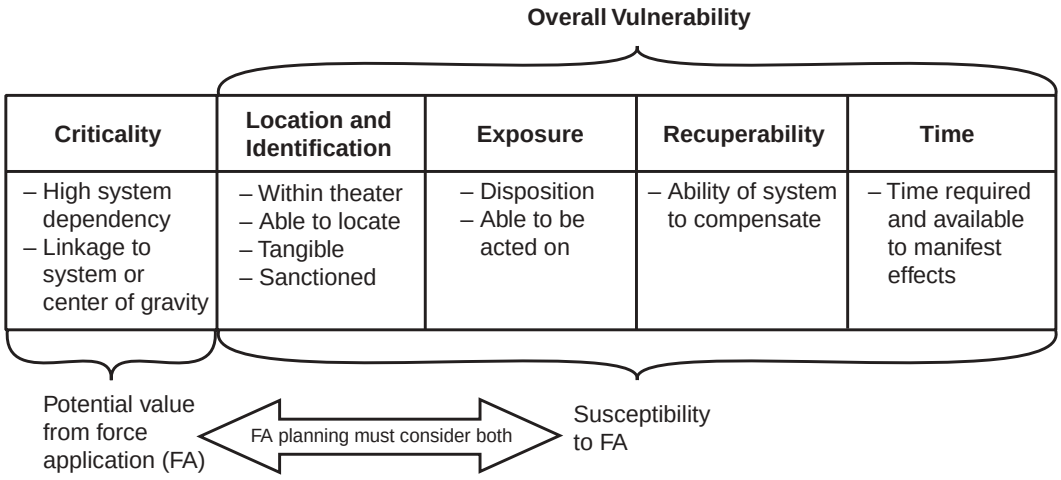


Figure 2. Criticality and Vulnerability

Criticality. System criticality is a central concept in assessing the relative merits of various FA alternatives.[13] In strategic terms, one must ask what systems are essential to the enemy's war making, war sustainment, and war will. In this sense an adversary can be pictured as being composed of three overarching systems: a war-making system, a war-sustainment system, and a war-will system—each of which includes a number of subcomponents. A general guide to establishing the criticality of a component is to look for a high level of system dependence upon it. Fundamentally, a part that is essential to its whole also describes a dependency of that whole to the part. In other words, if one can affect a critical component of a COG, then one affects the whole COG without having to affect each component in detail. However, whether a critical component is an attractive COG for FA depends not only on its criticality but also on its vulnerability, which is a function of several key factors.

Vulnerability: Location and Identification. In order for a system to be vulnerable, one must be able to affect it.[14] A key consideration is whether the COG or system can be identified and located. Identification refers to whether or not a given system includes physical objects that are

susceptible to attack.[15] Once a system has been identified for possible FA, it is necessary to locate it. Location in this sense means analyzing both the complete layout and the component functions of the system in order to determine where best to apply force to achieve disproportionate results.

Exposure. Assuming a system can be identified and located, the question remains of whether or not action upon it is possible. Is the system concealed, hardened, or otherwise protected? How much action is required to uncover, penetrate, or expose that segment or segments of a system one wishes to act on? Exposure essentially has to do with the relative ease or difficulty of applying effective force against a given system.

Recuperability. When considering overall vulnerability, one must also assess a system's recuperability. If a system can be easily repaired, replaced, or bypassed—that system's recuperability is high, which lowers vulnerability.[16] An additional consideration when assessing recuperability is substitution. It may be necessary to attack not only the primary components of a system but also those components and activities that may compensate or substitute for it.[17]

Time. Time is also a subtle factor of both criticality and vulnerability. If the desired effects from attacking a system must be generated within a certain time period to be of use and if the effects will probably be delayed (or are indeterminate), then while the system is technically vulnerable, the value of attacking it will not be realized—so it is not critical.

Leverage

Achieving leverage is a central concept of operational art.[18] Leverage can be defined as being able to achieve disproportionate results with a relatively small effort. This is a product of timing, maneuver, fires, and asymmetry, the latter referring both to applying strength against weakness and to a dissimilarity in opposing forces (e.g., using airpower against surface forces).[19]

A central challenge of FA planning is where best to place the levers. Logically, leverage should be applied where it will have the greatest effect on an adversary. Operational art has an intertwined nature combining economy of effort with leverage, which is linked to assessing and acting upon operational and strategic COGs. JP 3-0 describes leverage as follows: "JFCs gain decisive advantage over the enemy through leverage. This leverage can be achieved in a variety of ways. Asymmetrical actions that pit joint force strengths against enemy weaknesses . . . can provide decisive advantage. Dimensional superiority, isolation of the enemy, and attack of enemy strategic [and operational] centers of gravity can contribute to joint force leverage."[20]

Two additional aspects related to leverage need discussion: resistance and balance. Offensive strategy strives to reduce the opponent's resistance and disrupt his balance, while defensive strategy attempts to conserve friendly resistance and maintain one's own balance. Carl von Clausewitz and B. H. Liddell Hart indirectly illustrate the concepts of resistance and balance in their analogies between war and wrestling. They

both see the opponent's power as being made up of physical and psychological forces. They disagree over how the opponent is to be thrown. Clausewitz believes that the stronger opponent with the greater power of resistance will prevail; he will triumph through strength of total means and will. Liddell Hart also believes the stronger, more concentrated force will win; but he contends that the way to obtain this advantage is to upset the opponent's equilibrium first and then throw him using superior leverage.[21] Implicit in these two treatments of leverage are the dual ideas of resistance and balance and, by abstraction, the potential leverage that can be gained by acting on centers of resisting ability, resisting will, and physical and psychological balance.[22]

Thus, leverage can be defined as selective FA that achieves disproportionate effects. Intertwined with leverage are the concepts of timing, asymmetry, COGs (criticality and vulnerability), and centers of resistance and balance.

Direct and Indirect Approaches

Several important facets of operational art can be combined into direct and indirect approaches to FA. An outline of a direct and indirect approach framework to FA is depicted in table 2.

Table 2

Direct and Indirect Approaches

Direct Approach	*Indirect Approach*
Contested positional advantage	Creating positional advantage
Attacking enemy strength (COGs) without first upsetting balance or reducing functional resistance	Attacking enemy resistance by upsetting balance and reducing functional resistance in order to first create vulnerability*
Focus on Forces	*Focus on Functions***
Overcome total resistance by concentrating on enemy forces	Overcome total resistance by concentrating on enemy functions

*Joint Publication (JP) 3-0, *Doctrine for Joint Operations,* 1 February 1995, III-21.
**JP 3-0, III-17.

The idea of attacking enemy strength directly is associated with Clausewitz and linked to his concept of overwhelming resistance through superior power.[23] Traditionally, applying force on force has been envisioned as being symmetrical—for example, land force on land force. This vision is being challenged through the concept of asymmetry, which seeks dissimilar force-on-force pairings.[24]

The alternative of first upsetting an adversary's balance in order to create vulnerability (leverage) by attacking an enemy's functions is related to Liddell Hart's idea of the indirect approach.[25] Functions within the framework (see table 2) represent an adversary's war sustainment and war will.

Specific examples of functions include command, control, and communications (C^3), resupply, and air defense as well as military capabilities, rear areas, military morale, and public opinion and support.[26]

The overall efficacy of an indirect approach to FA is closely related to the time required and available for effects to be generated and matured. Functional effects take time to affect the critical system functions they are planned against. The essence of an indirect approach is captured in the following extract from JP 3-0:

> JFCs can focus on destroying and disrupting critical enemy functions such as C^2, resupply, and air defense. Attack of an enemy's functions is normally intended to destroy enemy balance, thereby creating vulnerabilities to be exploited. Destruction or disruption of critical enemy functions can create uncertainty, confusion, and even panic in enemy leadership and forces and may contribute directly to the collapse of enemy capability and will. The appropriateness of functional attack as the principal design concept frequently is based on time required and available to cripple enemy critical functions as well as the enemy's current actions and likely response to such attacks.[27]

System and Nodal Analyses

Nodal analysis is a subset of system analysis, which is frequently used within the military as a means of target assessment. It is a methodology that decomposes an adversary, viewed as a system, into interconnected and related subsystems and target complexes.[28]

System and nodal analyses are mental routines that seem to make an adversary comprehensible and seem to organize choices for FA. By reducing an adversary to a network of systems, one imposes a structure that allows the relative merit of differing FA schemes to be studied.[29] The purpose is to decompose an adversary's composite resistance into exploitable forces and functions. Operational art then continues the task—identifying COGs in terms of forces, functions, and potential avenues to affect them.

Target

The current focus of FA is targets. This study proposes shifting its focus to effects (the basis of this shift is discussed in detail in chap. 4). That is, FA should focus on destruction of targets as a means to achieving effects, which are linked to objectives, and not on destruction of targets as an end in itself.[30] This shift will essentially establish effects as intermediate objectives between targets and objectives and should help link the process (see fig. 3).

Thus far, a target has been described as an object, as a means of achieving ends (objectives and effects), and as part of a greater chain within the FA process. A single target may be sufficient in itself to be an end, but this is rare; more often a target is significant because of its relationship to a greater system.[31] The term *target* in this study refers to the component level (and below) and to the physical object identified for weapon impact within a given system.

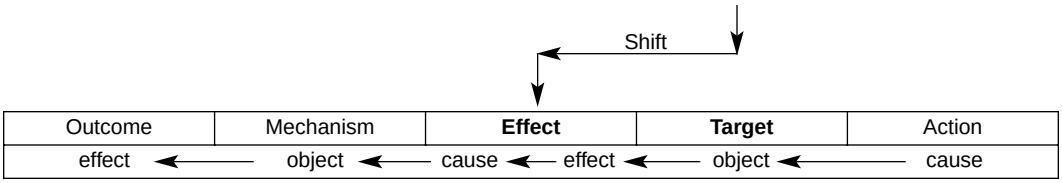


Figure 3. Framework of the Force-Application Process

Strategies-to-Task Methodology

Strategies to task (STT), a planning methodology developed by RAND for the Air Force in 1989, was originally developed for planning force structure, capabilities, and requirements.[32] STT is a planning process to link national objectives and strategy to operational concepts, capabilities, and tasks in a coherent and accountable fashion. It is widely used in Air Combat Command (ACC) in the Requirements Directorate to organize and evaluate requirements.

Around 1992, STT was adapted to FA planning. The methodology is similar to STT; but instead of relating requirements to national defense objectives, it relates targets to national policy objectives. Specifically, the adapted framework logically links a hierarchy of objectives to tasks and tasks to targets. The objectives are organized in a hierarchical order from national security objectives to the combatant commander/joint force commander (JFC) theater objectives, to air tasks down to individual targets. This linked and hierarchical nature of objectives is commonly called a Z diagram, which describes a congruent linkage between objectives and strategy at each level of planning (fig. 4).

Contribution. STT's primary contribution is as a planning tool. It forces clarifications and decisions on objectives at multiple levels of policy. It imposes order and structure through the use of objectives and tasks. By following the STT methodology, one prioritizes, sequences, compartments, and monitors objectives and tasks.

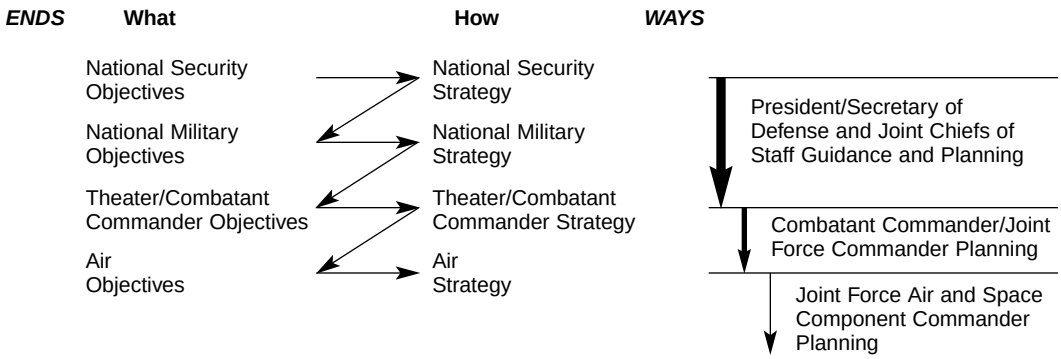


Figure 4. Z Diagram

Incompatibility with Effects. By sorting objectives, tasks, targets, and measures of merit (MOM) into bins, STT facilitates a rational process and clear audit of objectives, tasks, and targets for FA. However, it accomplishes this at the price of being static, sequential, and target based. Its primary incompatibility with effects is that it does not recognize them within the process. In reality, effects do not stay confined within the STT bins; rather, their nature is to cross over the bin partitions contributing to multiple objectives (see fig. 5).

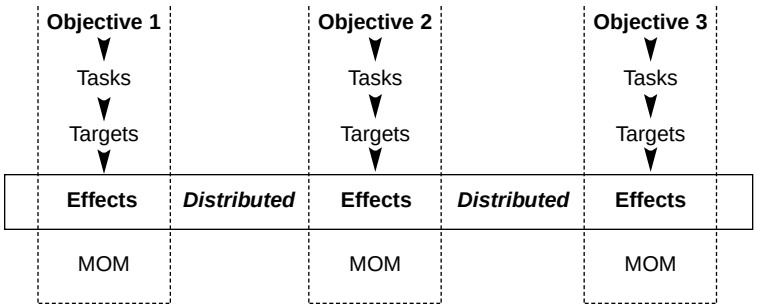


Figure 5. Distributed Effects

In short, STT modeling does not capture the distributed nature of effects. This inability to plan for and capture distributed effects and their crossover contribution to multiple objectives influences decisions concerning economy of effort. What is overlooked is the synergistic nature of effects to compound and distribute influence throughout the breadth and depth of an opponent as a system. The STT methodology is a useful tool to prioritize and organize objectives, but its use should stop at the determination of objectives and allow subsequent planning to focus on effects as a means to achieve objectives. It should be used as a tool and guide to judgment, not as a replacement for judgment.

Levels of War

The strategic, operational, and tactical levels of war are well established.[33] Most Department of Defense documents refer to the definitions set forth in JP 1-02, *Department of Defense Dictionary of Military and Associated Terms*. This section will not challenge the established definitions but will supplement them with a systems-and-effects-based perspective. This study assumes a single theater of war.

Strategic. The strategic level of war describes activities associated with the theater of war (i.e., the war as a whole). At this level, the adversary state/entity is considered in terms of a whole system that is a dynamic composite of the major war functions of war making, war sustaining, and war willingness. Strategic effects contribute to reducing and unbalancing the enemy's overall political, military, and economic capacities as well as

his psychological stability. Strategic effects in general require a longer time to manifest themselves than do effects at the operational and tactical levels.

Operational. The operational level of war describes activities associated with campaigns and major operations. At this level, systems efforts focus on the war-making function of the enemy. The principal focus at this level is on enemy forces, the enemy's center of hostile ability. Operational effects contribute to reducing and unbalancing the enemy's capacity to conduct successful campaigns and wage war. Operational effects usually take less time to be realized than do strategic ones but are less immediate than effects at the tactical level.

Tactical. The tactical level of war describes activities associated with battles and engagements. It is the level of war most directly associated with the enemy's war making. The focus at this level is on individual units. Tactical effects contribute to reducing and unbalancing the enemy's capacity to conduct battles on a relatively localized basis. The effects are immediate and of short duration. The levels of war are summarized in the matrix (see table 3).

Caveat. There is a tension in this study between the need to plan effects using the levels-of-war schema and the tendency of effects to propagate across the levels of war. This tension represents a trade-off between the levels being useful for organizing and selecting FA efforts and the tendency for the effects to transcend the levels. This is another way of saying that effects have a tendency to become distributed and exploit the interconnected and synergistic nature that exists across the levels of war, despite our planning and compartmentalization of effects. This tension will not be resolved within this study.[34]

Table 3

Levels of War

	Strategic	*Operational*	*Tactical*
Scope and scale of interest (JP 3-0)	Theater; war as a whole	Campaign and major operations	Battles and engagements
Major functional focus for FA	War Sustainment and War Will	War Making	
Centers of Gravity	FUNCTIONS—infrastructure, logistics, and will	FORCES—the capacity from which a military force derives its freedom of action, physical strength, or will to fight	
Effects (JP 3-05.5)	Contribute to reducing and unbalancing the enemy's overall political, military, and economic capacities and respective psychological stability (hostile will)	Contribute to reducing and unbalancing the enemy's capacity to conduct successful campaigns and wage war (hostile ability)	Contribute to reducing and unbalancing the enemy's capacity to conduct battles on a relatively localized basis
Time required for effects to manifest	Long term	Midterm	Immediate

Author's Note: The lines separating the levels are not meant as rigid boundaries. Force applied at the various levels potentially distributes effects across the levels. For an expanded version of this matrix reference, see appendix C.

Emerging Concepts

Several new concepts of FA are being brought forward to challenge as well as complement the existing terms and concepts.[35] These may allow for a less mechanistic and procedural approach to FA by better representing the nature of operational art as experiential and heuristic in nature. The new sense of operational art suggests that military strategy and FA are better approached as processes than as set procedures. FA as a process implies that FA planning should proceed in a successive manner using FA effectiveness assessments as principal guides to future actions.

Effects

In this study, effects possess a dual nature. They are both results (effects) of change and at the same time triggers (causes) for subsequent outcomes (see fig. 6).[36] Consider for example, a regional air defense (AD) integrated operations center (IOC) that is bombed and destroyed (first-order effect). Subsequently, this *destruction* in turn *causes* all regional AD units in the network to lose their air pictures and centralized control (second-order effect). Due to this regional AD degradation in command and control (C^2), units within the region are forced to act autonomously with limited air pictures and thereby lose economies previously realized by integrating their efforts (third-order effect). In short, FA continues beyond its first-order effect (destruction) as it translates into a cause of second-order and higher-order effects. Effects are a bridge between objectives and targets serving essentially as intermediate objectives. By developing desired effects, FA planners can better conceptualize the linkage between objectives and targets and therefore increase the probability of the causal chain's maintaining its coherence.

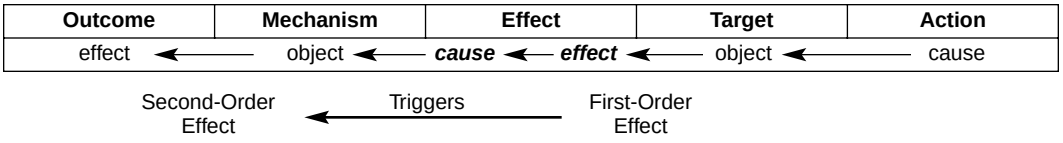


Figure 6. The Dual Nature of Effects

Mechanism

A core concept in this study is that of a mechanism, which is at once a theory, a belief, and a conceptual linkage that couples targets to effects, to objectives, and to ultimate political outcomes.[37] Essentially, a mechanism is a belief in a cause-and-effect relationship.[38] It should explain the critical *why* question for the FA planner, providing the rationale for why a particular target-to-effect pairing should contribute towards fulfilling the objective.[39] A mechanism should answer the *because* question in a typical FA cause-and-effect sequence, as in if we strike these targets producing

these effects, then they will contribute to fulfilling these objectives *because* . . .; it is a rationale, *a logic of causality*.

The concept of mechanisms is not widely accepted in FA and is only now starting to emerge as part of the overall operational-art methodology and lexicon (at least within airpower operational art).[40] In truth, this critical analytical step is often overlooked. What often takes its place is a largely implicit belief in certain target-effect pairings that have evolved below a threshold of awareness as common beliefs.[41] Some of these FA beliefs are investigated and made explicit in chapter 6, which discusses some common mechanisms.

A mechanism, as an embedded and mostly implicit rationale for particular FA schemas, can be written out in long form as a declaration. This declaration for an FA planner would read as follows: by acting on this target (material) in this manner (weapon effect) we intend this destruction/damage (first-order effect). The first-order effect will in turn trigger the following second-order effects. The second-order effects will subsequently influence these areas, systems, and/or subjects and contribute to the fulfillment of the following objectives (ultimately modifying political behavior). We believe in this chain of cause and effect because of (1) history/doctrine, (2) logic and analysis, (3) intuition, (4) faith, or (5) hypothesis.

Implicit within FA viewed in the broadest terms is the idea of modifying material in order to modify behavior.[42] The target describes the material object, and the effect describes the first-order resultants of the target modification. The effects then in their dual nature become subsequent triggers (causes, second-order effects) that modify behavior. The key question is whose or what behavior do they modify? This study asserts, as depicted in figure 7, that a *mechanism* as an *object* contains three general categories for behavioral modification. Second-order effects can act on and

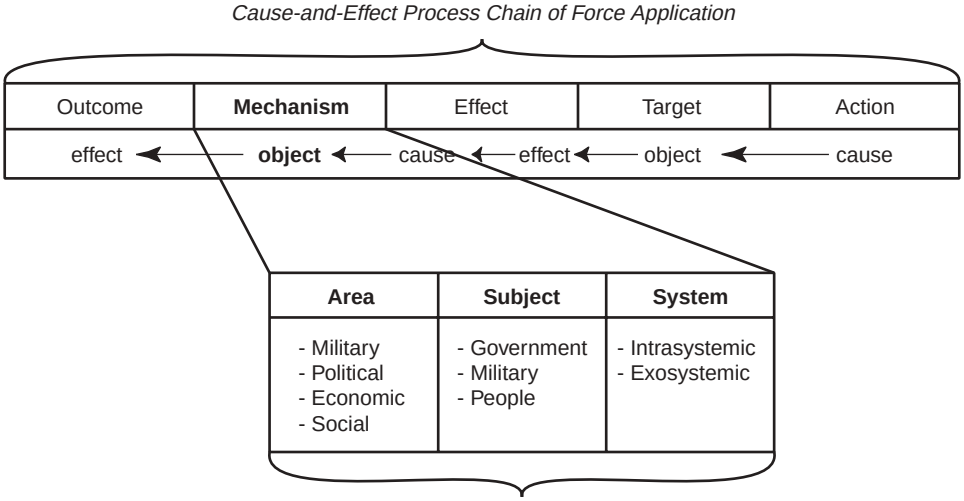


Figure 7. Object Categories Embedded in a Mechanism

influence the military, political, economic, or social (MPES) areas;[43] the government, the military, or the people;[44] or the targeted system (intrasystemic) or a connected system (exosystemic).[45] This is not to preclude a mechanism from acting on any combination of these objects. Indeed, this is a large part of the uncertainty involved with predicting second-order and higher-order effects; one cannot be certain of the exact nature of the influence. However, given reasonable assumptions of cause and effect and knowledge of the target, one can develop and achieve intended second-order effects.

Tight and Loose Coupling

These terms pertain to expectations and planning related to system effects. Assessment of tight and loose coupling examines a node's functional relationships within the system it is part of and its function in relation to other connected systems.[46]

Tight and loose coupling describes connectivity within a system and/or its connectivity to other systems. It attempts to describe relationships within a system or between systems in terms of dependent behavior, slack (excess or compensating capacity), time criticality, and vulnerability to outside disturbance (effects) (see table 4).[47] These connective relationships are important considerations for the FA planner because they are a critical part of the overall analysis to determine the most effective way to affect a given system or systems. By understanding the internal and connective relationships within given systems of interest, an FA planner can achieve disproportionate functional effects (leverage).

Table 4

Tight and Loose Coupling

Tight Coupling	*Aspect*	*Loose Coupling*
Strong dependencies	*Dependent relationship*	Relative independence
Little give or slack	*Capacity*	Give and slack exist
Time critical	*Time*	Not time critical
Disturbances propagate	*Effects vulnerability*	Relative independence from disturbances

Systems that are tightly coupled have a greater potential to be affected by disruptive influences; therefore, they are of special interest to FA planners.[48] Tightly coupled systems are more critical than loosely coupled systems because they depend (internally or externally) on input and control to sustain and regulate them. Examples of such dependency include fuel (input) for electrical generators and transmitted commands (control) via a communications network for electrical systems.

Nodal analysis assesses system criticality by identifying critical nodes. Assessment of tight and loose coupling complements nodal analysis by further qualifying a system's criticality and vulnerability. Vulnerability

can be qualified in the sense that in a tightly coupled system, there is a reduced capacity for the system to be able to self-compensate (recuperability). Moreover, tight coupling implies there is little or no slack for compensation (work-arounds), and that disturbances will immediately propagate throughout the system—and potentially outside of it.

Complexity Theory and Newtonian Physics

Military theorists have always been interested in what the sciences can offer for insight into natural laws and ways to order phenomena.[49] This interest exists because war is a natural phenomenon, and insights into natural laws may also offer potential insight into the nature of war. Newtonian physics has been the primary foundation for centuries of military thought.[50] The primary tools that Newtonian physics offers are reductionism and linearity.[51] However, these notions of simple reductionism and predictive linearity are increasingly being challenged as poorly fitted to war.

Newtonian Paradigm. The cornerstone of the Newtonian paradigm is linearity, which, with its properties of proportionality and superposition (where the whole is equal to the sum of the parts), provides for predictability.[52] This predictive ability is possible with linearity because, in principle, effects are calculable from their underlying causes.[53] A logical consequence of the assumed ability to predict future outcomes, given sufficient information on the causes, is the desire for more perfect information. Despite this predictive ability, perfect information is difficult to come by, and outcomes in war are frequently unanticipated.

An additional consequence of linear thinking about war is reductionism. A reductionist approach divides a given whole into smaller parts then solves the parts individually, by adding the parts back together in the end to form a whole solution. This approach itself is not flawed. It is a logical extension of superposition and additivity, where the whole is assumed to be the sum of its parts.[54] However, the consequences of this method are oversimplification and a tendency to fragment analysis efforts into individual pieces; what is lost is a holistic analysis that deliberately considers the enemy as a complex whole.

Complexity Theory. Complexity theory is an emerging paradigm that holds promise as a new framework for understanding warfare. It seems to have a greater capacity to account for the interactive and nonlinear phenomena of warfare than does the existing Newtonian framework. Specifically, complexity theory holds that opponents in warfare are interactive and continually evolving; therefore, it anticipates that outcomes are more dynamic and less certain than a more linear view would assume.

The cornerstone of complexity theory is nonlinearity. *In this framework, effects need no longer be proportionate to causes; although this frustrates prediction, it more closely fits experience*. Additionally, nonlinearity allows for the possibility of synergistic consequences where the whole may be greater than the sum of the parts.[55]

Linear Systems and Nonlinear Systems

Increased awareness of cause-and-effect relationships is an important aid to understanding dynamic interactions in war. Linearity and nonlinearity offer two different classes of cause-and-effect relationships. Their differing viewpoints on system interactions and proportionality are important to understanding and developing an effects-based approach to FA (see table 5). For an expanded matrix and explanation on linear and nonlinear systems, see appendix D.

Table 5

Linear and Nonlinear Systems

Linear	*Nonlinear*
Defining Characteristics	
A system is linear if it meets two simple conditions	A system is nonlinear if it does not display the conditions of linearity
First Condition: Proportionality—changes in system output are proportional to changes in system input	Disobeys proportionality: changes in system output are erratic, exhibiting disproportionately large or small outputs
Second Condition: Additivity or Superposition—the whole is equal to the sum of its parts	May involve synergistic interactions in which the whole is not equal to the sum of the parts
Systems and Effects	
Views systems in isolation	Views systems as being interconnected and interactive, both internally and externally
Effects are isolated within a given system acted upon	Allows for effects to cross over systems and act simultaneously upon multiple systems
Effects are in proportion to their causes	Effects can be disproportionate to their causes
Effects are largely sequential	Allows for effects to occur in parallel

Linear Systems. A system is linear if it meets two simple conditions. The first is proportionality, where changes in system output are proportional to changes in system input.[56] The second condition is additivity or superposition, where the whole is equal to the sum of its parts.[57]

Nonlinear Systems. A system is nonlinear if it does not display the conditions of linearity. A nonlinear system generally disobeys proportionality, where changes in system output are erratic, exhibiting disproportionately large or small outputs. Additionally, nonlinearity may involve synergistic interactions, in which the whole is not equal to the sum of its parts.[58]

Implications for Systems-and-Effects-Based FA. Linear concepts tend to view systems as acting in isolation.[59] This means that effects are not recognized as having any influence or distributed effect outside the system. Additionally, these intrasystem effects are assumed to be proportional to their causes and to occur sequentially within the system. STT, with its compartmentalization of objectives and targets, is an example of a linear framework and effects presumed to occur in isolation.

Nonlinearity, on the other hand, views systems as being interconnected and interactive both internally and externally. While this is more complex than linear concepts, it allows for a far richer context and potential for effects to propagate within and outside a system. Indeed, this is a hallmark of nonlinear effects: these effects cross over systems and act simultaneously upon multiple systems.[60] Moreover, nonlinearity allows for effects to be disproportionate to their causes, which offers the potential for FA leverage within and across systems. Finally, because systems are interconnected and interactive, nonlinearity provides for effects to occur in parallel.

By recognizing that systems can exhibit both linear and nonlinear properties, an FA planner gains a better viewpoint for developing effective FA. This viewpoint provides an understanding that effects from a given FA versus a system can be proportional as well as disproportionately small or large. Additionally, FA effects can be isolated within a system or distributed outside the system, depending on the coupling of the system and its connectivity.

The real potential for an effects-based approach to FA is the acknowledgment that a great deal of warfare is nonlinear. Indeed, we find that results in war quite often occur out of proportion to actions. What has been missing in a conceptual framework for FA and effects is the holistic viewpoint that embraces the properties of complexity, interactivity, and connectivity within systems. Essentially, complexity theory provides the potential to begin to examine nonlinear effects. Specifically, the theory can aid examination of those second-order and higher-order effects that result from complex interactions and system connectivities. This exploration into nonlinear effects promises to improve our understanding of mechanisms for FA. If we can achieve a deeper understanding of the causal relationships and behavior within and between systems, we should be able to design FA strategies to achieve our ultimate outcomes more efficiently and effectively than we could without such understanding.

Summary

One should not throw out the Newtonian paradigm altogether but supplement it and begin to look for opportunities to transition in outlook when and where appropriate. The Newtonian framework and the emerging complexity framework are not mutually exclusive. Some cause-and-effect relationships are linear. For example, destruction and damage are usually proportionate to warhead size and accuracy. What complexity theory really provides is a greater sense of the dynamics of warfare. Indeed, by necessity one must reduce the whole of warfare, and reductionism provides a methodology to accomplish this decomposition and simplification. However, given that a certain amount of reductionism is unavoidable in warfare, one should appreciate its pitfalls and balance it with a holistic approach.

Notes

1. Joint Publication (JP) 3-0, *Doctrine for Joint Operations*, 1 February 1995. A broad and comprehensive treatment of operational art is provided in chap. 3, "Planning Joint Operations," sec. 5, "Operational Art," III-9-23.

2. Army Field Manual (FM) 100-5, *Operations*, June 1993, 6-2. In shorthand, this definition can now read as follows: operational art consists of the ways to link ends and means together coherently to obtain the desired political outcomes. And by further abstraction: op art consists of the manner in which objectives are coherently linked to effects to fulfill desired political outcomes.

3. JP 3-0, xi and III-20.

4. Steven Metz and Lt Col Frederick M. Downey, US Army, "Centers of Gravity and Strategic Planning," *Military Review* 68, no. 4 (April 1988): 25–26. Although the work is dated (1988) and draws its analysis from the 1986 edition of FM 100-5, I find it insightful.

5. JP 3-0, xi.

6. Ibid., III-20-21. What JP 3-0 is trying to convey is that a direct attack on an enemy's forces may not be possible due to their strong defenses; therefore, an indirect attack to weaken their strength may be warranted. I have taken this idea and broadened it considerably to an interpretation of relating a direct approach to military forces and an indirect approach to other than military forces.

7. Robert Pape, *Bombing to Win*: *Air Power and Coercion in War* (Ithaca, N.Y.: Cornell University Press, 1996). Indeed, this is the central thesis of his book—the idea that the only real objective (COG) should be the enemy's military forces (his denial strategy). Pape's argument holds that there is little or no merit in attacks against war sustainment or war will. This study argues indirectly that Pape excludes the possibility that attacks at multiple levels of war and multiple COGs are synergistic. Perhaps it is not *an either-or proposition* to, in his terminology, adopt either a strategy of denial, punishment, or decapitation, but rather, *a both-and proposition*, combining and sequencing strategies dynamically to fit the situation. In essence, effects are cumulative, interactive, and synergistic across the levels of war.

8. It increases because interconnectivity and interaction increase both in absolute numbers and frequency when moving from the tactical to the strategic level. Because of this increase in complexity and relationships, the linear propositions of proportionality and additivity decline. Hence the operational and strategic levels of war exhibit a more nonlinear character.

9. It is somewhat contentious whether there is just one true COG or alternatively multiple COGs. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976); and Naval Doctrine Publication 1, *Naval Warfare*, 28 March 1994, 35, hold that there, like the "Highlander," can be but one. Alternatively, JP 3-0, *Doctrine for Joint Operations*, 10 September 2001 (III-20) and Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine* (24, 51), discuss multiple COGs.

10. JP 3-0, III-20.

11. John A. Warden III, *The Air Campaign: Planning for Combat* (Washington, D.C.: Pergamon-Brassey's, 1989), 37, 45, 47, and 54; JP 3-05.5, *Joint Special Operations Targeting and Mission Planning Procedures*, 10 August 1993, II-3-11; and JP 1-02, 106, 107, and 464.

12. It is important to keep in mind that there is a constant duality to basic military strategy and force application, where duality is what one can do to affect the opponent to exploit his weaknesses and what one can do to protect one's own weaknesses—essentially, to assess and act on the opponent and to assess and protect oneself. In the interest of scope and time in this study, the focus is on assessing and acting on the opponent; however, the reader would do well to remember that strategy is a two-way street.

13. JP 3-05.5 defines criticality in part as follows: "A target is critical when its destruction or damage would significantly impair an enemy's political, economic, or military opera-

tions" (II-8). This can be supplemented with an additional operation. When analyzing FA effects, the Joint Warfare Analysis Center assesses them in terms of national value related to four areas: military, political, economic, and social.

14. The ability to affect a system is in turn dependent on the action being within bounds and sanctioned. *Within bounds* refers to within the geographic combatant commander's area of responsibility (AOR), and *sanctioned* refers to meeting the restraints and constraints guidance directed by the president and secretary of defense.

15. For example, an enemy's fielded forces, as a system, generate a high degree of identification. There is little difficulty in associated physical objects to this system. On the other hand, an enemy's national resolve (will) has a poor identification value. It is very difficult to directly associate physical objects to will. This is an extremely important consideration for an effects-based approach to FA. This, in part, explains the vexing nature of linking target-and-effect pairings to war sustainment and war will.

16. Ibid.

17. Mancur Olson Jr., "The Economics of Target Selection for the Combined Bomber Offensive," *Royal United Services Institute Journal* 107 (November 1962): 308–14. The idea of compensation and substitution will be developed more fully in chap. 3.

18. JP 3-0, III-14.

19. Ibid., III-10.

20. Ibid., III-15.

21. Clausewitz, 75 and 77; B. H. Liddell Hart, *Strategy* (New York: Meridian, 1991), 5–6, 146. "The most effective indirect approach is one that lures or startles the opponent into a false move—so that, as in jujitsu, his own effort is turned into the lever of his overthrow."

22. Clausewitz and Liddell Hart do not explicitly discuss any concepts of leverage; the author is interpreting them as discussing it implicitly and applying their work to the concept of leverage.

23. Clausewitz, 75, 77, 89, 97, 184, and 485–86. In Clausewitz's formulation, total resistance is a product of total means times strength of will. Hence, victory is gained by overwhelming an opponent through the imposition of superior physical and psychological force. Essentially, one outlasts and overwhelms an adversary—similar to the methodology applied to winning a sumo wrestling match.

24. Asymmetry has been previously discussed; see JP 3-0, III-10. The notion of emerging asymmetrical leverages is developed in *Burner Climb*, a soon-to-be published work by Benjamin S. Lambeth. He argues that airpower on land power by virtue of Operation Desert Storm is a proven asymmetry for exploitation. This same potential is developed more formally in AFDD 1, 48–50, especially the section on "Counterland."

25. Liddell Hart, 6, 146–47, 325–27, 336, 345, and 347.

26. JP 3-0, III-17, 21.

27. Ibid., III-17.

28. JP 3-05.5, II-5-11.

29. This concept of thinking of the enemy in terms of a system has most recently been attributed to John A. Warden III. It is not new and has its origins at least as far back as World War II. Surprisingly, this idea of the enemy as a system seems to be rejected by many of my peers. This is surprising because it is pervasive in military-targeting science of both the past and present. Its discounting appears at times to be more of an emotional backlash towards Warden than anything else.

30. Output-based or objective-based targeting versus input-based targeting. Steven M. Rinaldi, *Beyond the Industrial Web: Economic Synergies and Targeting Methodologies* (Maxwell AFB, Ala.: Air University Press, 1995).

31. In order to appreciate fully a systems-and-effects-based approach to FA, it is helpful to examine the diverse vocabulary established to describe a hierarchical set of target definitions (see appendix A). The target system hierarchy (appendix A) is extracted and developed directly from JP 3-05.5 (II-5-7). The main points to take from appendix A are its systems orientation and the level within which a target will be referred to in this study.

32. Glenn A. Kent, *A Framework for Defense Planning*, RAND/R-3721-AF/OSD (Santa Monica, Calif.: RAND, 1989).

33. A sampling of documents with JP 1-02's universal definition includes JP 3-0, JP 3-05.5, AFDD 1, and AFDD 2-1.2, "Strategic Attack," draft, December 1997.

34. This tension has already been discussed indirectly with the conflict between STT and distributed effects (see appendix B). Additionally, in the next section, this tension can be seen as one between a reductionist methodology to FA planning and an approach based on complexity theory. This tension can further be described as one between linear and nonlinear views to the nature of warfare and its cause-and-effect relationships (see appendix D).

35. David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995); Alan Beyerchen, "Clausewitz, Nonlinearity, and the Unpredictability of War," *International Security* 17, no. 3 (winter 1992/93), 59–90; Pat A. Pentland, "Center of Gravity Analysis and Chaos Theory" (Maxwell AFB, Ala.: Air War College thesis, 1993); Steven M. Rinaldi, "Systems Warfare," lecture, Air Command and Staff College, Connections '98 Conference, Maxwell AFB, Ala., 26 February 1998; David S. Alberts and Thomas J. Czerwinski, eds., *Complexity, Global Politics, and National Security* (Washington, D.C.: National Defense University, 1997); Barry D. Watts, "Ignoring Reality," *International Security Studies* 7, no. 2 (winter 1997/98): 114–69; Rebecca Grant, ed., *Origins of the Deep Attack Weapons Mix Study* (Arlington, Va.: IRIS Independent Research, 1997), pt. 5; and John R. Boyd, "A Discourse on Winning and Losing," lecture notes (Maxwell AFB, Ala., August 1987).

36. Robert A. Pape, *Bombing to Win: Air Power and Coercion in War* (Ithaca, N.Y.: Cornell University Press, 1996), 56–57. This framework is adapted from Pape's work. The *effects* link is an addition generated within this study. This new framework is a core-process construct that is used throughout this study.

37. James N. Rosenau, "Many Da-- Things Simultaneously: Complexity Theory and World Affairs," in *Complexity, Global Politics, and National Security*, 92. A mechanism as a "theory [should] provide guidelines; it sensitizes planners to alternative possibilities; it highlights where levers might be pulled and influence wielded; it links ends to means and strategies to resources; and perhaps most of all, it infuses context and pattern into a welter of seemingly disarrayed and unrelated phenomena." The author has substituted the word *planner* for the word *observer* in the original.

38. Pape, 56–57.

39. Maris McCrabb, "The Operational Art in Air Operations Planning: Linking Ends, Ways, and Means," Research report (Maxwell AFB, Ala.: Air War College, 1996), 67, 69, and 75.

40. AFDD 2-1.2, 20. This draft document mentions it as part of an overall COG development-and-planning framework but then never develops or defines it.

41. McCrabb, 67.

42. The paradigms are discussed in greater detail in chap. 7. A basic thesis of this study is that a disconnect exists between these two paradigms, which contributes to a loss in FA effectiveness and economy of effort.

43. Pat "Curly" Pence, "JWAC Overview," briefing slides, School of Advanced Airpower Studies, Maxwell AFB, Ala., 3 December 1997. The JWAC calls these four areas "elements of national power." JWAC essentially performs effects-based precision-targeting analysis for the theater commands. Their systems-type analysis considers the impact to the MPES areas of the adversary as a matter of routine. JWAC is discussed in more detail in chap. 3.

44. Clausewitz, 89.

45. This list of embedded objects, subjects, and areas that a mechanism can incorporate and plan to influence is not exhaustive. Chap. 5 develops organizing schemes that expand on the "what" and "whom" implicit in mechanisms.

46. Mark D. Mandeles, "Command and Control in the Gulf War: A Military Revolution in Airpower," in *The Eagle in the Desert*, ed. William Head and Earl H. Tilford Jr. (Westport, Conn.: Praeger, 1996), 169.

47. Rinaldi, “Systems Warfare,” lecture.

48. Ibid. This area is liberally borrowed from Rinaldi’s briefing, particularly his systems-warfare section (within the briefing) dealing with complex systems.

49. Steven M. Rinaldi, “Complexity Theory and Airpower: New Paradigm for Airpower in the 21st Century,” in *Complexity, Global Politics, and National Security*, 247–50; and Lt Col Robert P. Pellegrini, USA, *The Links between Science, Philosophy, and Military Theory: Understanding the Past, Implications for the Future* (Maxwell AFB, Ala.: Air University Press, 1997), v, 42–45.

50. Rinaldi, “Complexity Theory and Airpower,” 248.

51. Ibid., 251–53.

52. Ibid., 252.

53. Ibid., 250. This can be stated mathematically as follows: if some input X to the system gives an output Y, then multiplying the input by a constant factor A yields an output AY. What this implies is, given enough information about the inputs and factors influencing the input, one can determine the output. In warfare, this develops a type of determinism based on perfect intelligence of inputs and factors to predict outcomes.

54. Ibid. Superposition, too, can be stated mathematically: if inputs X1 and X2 give outputs Y1 and Y2, respectively, then an input equal to X1 and X2 gives an output of Y1 plus Y2.

55. It is important to keep in mind that the whole can also be less than the sum of the parts. This either-or type of potential with complex or nonlinear effects will be developed as a kind of effects risk in chap. 4.

56. Beyerchen, 62.

57. Ibid.

58. Ibid.

59. Rinaldi, “Complexity Theory and Air Power,” 252–53.

60. Ibid.

Chapter 3

Systems Approach

Target system analysis is a systematic approach to determine enemy vulnerabilities and weaknesses to be exploited. It determines what effects will be achieved against target systems and their activities. A target analysis must review the systems and their interactions between components and elements of a target system to determine how the system works and, subsequently, how to attack that system so it becomes inoperable.

—Joint Publication 3-05.5
Joint Special Operations Targeting and Mission Planning Procedures

Systems analysis is a popular scientific methodology. The science is reflected in the rigor and systematic approach taken to decomposing a given system into subsystems, components, and elements.

This chapter examines how past airpower theorists have thought of the enemy in terms of systems. The mechanisms that the theorists developed linking their systems to defeating the enemy are also assessed. Study of their theories reveals that a systems approach as a targeting methodology is not new to present-day strategists or FA planners. Additionally, the systems selected by theorists for defeating an opponent are interpreted in terms of forces and functions. This classification of systems into forces or functions is a basic facet of operational art and a basic choice of FA planners for defeating the enemy.[1] By examining the rationales used by past theorists to support their choices between attacking either forces or functions, FA planners should be better prepared to make their own choices.

Systems analysis has become so accepted as an approach to FA that it is institutionalized today in the Joint Warfare Analysis Center (JWAC). The systems that JWAC specializes in analyzing are outlined, and a basic distinction is made between material analysis and nonmaterial or behavioral analysis.

Because of the traditional interest in infrastructure and economic systems as targets for strategic attack, the ideas of Olson on the resilience of economies are of special interest to FA planners. The last section of this chapter outlines what is meant within this study by a systems approach. Finally, an effects-based framework is developed as a supplement to a systems-based approach for relating FA to objectives.

Airpower, History, and Systems Thinking

Virtually from the beginning, airpower theorists have sought ways to influence adversaries in ways other than by directly attacking their armed forces. This desire has been maintained by a faith that directly attacking

an enemy's forces is uneconomical in blood and treasure. This faith is founded on a belief that armies are dispersed, committed, well defended, and require great effort and cost to affect. This conviction—coupled to airpower's greatly expanded operational reach—led to the pursuit of new targeting strategies to affect an adversary as a whole. This pursuit shifted the focus from a direct attack of enemy forces to an indirect approach focused on functions. The perspective of considering the adversary as a whole led to systems thinking and the subsequent need to reduce the opponent into comprehensible and related parts.

Giulio Douhet

Douhet, who formulated the first major theory of airpower, saw the potential of airpower to avoid warfare in the trenches and to attack the enemy in-depth. Douhet's systems thinking was clear in his approach to targeting an adversary. His concept addressed forces and functions of an opponent. His strategy to neutralize forces was to attack the transportation and supply of an army; attack the forces, supplies, and fuels of the navy; and attack the airfields of an air force.[2] However, his overarching mechanism for the defeat of an adversary was based on the moral vulnerability of civilian populations. The key linkage in Douhet's theory was that by bombing civilian population centers, one could break the material and moral resistance of the adversary and shatter his national resolve.[3]

William "Billy" Mitchell

Mitchell, a contemporary of Douhet, shared several similarities in viewpoint. Both Douhet and Mitchell conceived future war as being total, and both rejected the distinction between civilians and combatants.[4] This similarity in thought led Mitchell to select some systems and rationales similar to those of Douhet.

Mitchell's targeting strategies and underlying mechanisms, however, changed over time. What Mitchell did not change were the systems he considered vital, which included forces, transportation, industry, and will.[5] In the 1920s Mitchell focused on forces as the primary avenue to influence the war, with a lesser emphasis on transportation, industry, and the will of the people. Perhaps influenced by Douhet, in the 1930s his focus changed, shifting to the will of the people as the primary mechanism to victory. His last targeting strategy appeared in 1933 when he anticipated the Air Corps Tactical School (ACTS) by changing his primary mechanism for influencing the opponent to targeting industry.[6]

J. C. Slessor

Slessor was a British Royal Air Force officer who is best known for *Air Power and Armies*, which he wrote in 1936. Slessor's discussion of intelligence and effects makes a significant contribution to systems analysis and effects-based thinking for FA. He recognized that detailed intelligence

and analysis would be required to identify vital centers and decisive points for aerial attack: "The method of attack on production . . . demands a detailed and expert knowledge of the enemy's industrial system, of the communications linking the different parts of that system, and of the installations supplying it with power and light."[7] "Detailed intelligence about the enemy must be supplemented by *expert technical advice* from representatives of our own supply and transport services" (emphasis in original).[8] Slessor repeatedly states throughout his work that effective FA does not equal material destruction, which may well be a component of the overall effect, but Slessor emphasized that the functional effect was the outcome sought: "This then is the *object* of attack on production, the dislocation and restriction of output from war industry, not primarily the material destruction of plant and stocks" (emphasis in original).[9]

Although Slessor embraced airpower as being potentially decisive at all three levels of war, he focused on airpower and enemy armies at the operational level. His mechanism for defeating an army consisted of two alternatives, which were "not necessarily mutually exclusive": first, to defeat the actual forces of the army; and second, to disrupt its critical supply function (interdiction). Here again, Slessor argued that a force need not be defeated in detail if its fighting efficiency can be crippled by other means. The other means Slessor proposed were strategic interdiction of war production and operational interdiction of war supplies.[10] He reasoned that if the army is fighting, then direct attacks are more effective; and if it is at rest, indirect attacks on fighting efficiency might be more effective. However, Slessor did not trap himself with exclusive language and did not preclude the possibility of both alternatives being applied simultaneously.

Air Corps Tactical School

In the 1930s the United States Army ACTS continued in the tradition of Douhet and Mitchell to argue that airpower was inherently offensive and strategic. It held that airpower could be decisive by attacking an adversary indirectly through its economy.[11]

ACTS developed a unique framework for targeting the enemy as a system that was based on the enemy's national economic structure, known as the "industrial web theory."[12] The web consisted of the vital industries that make up a highly industrialized nation. Each strand of the web corresponded to an industry and its associated raw materials, plant machinery, power supplies, and workforce. An individual web consisted of several strands of a related industry: "Various combinations of webs, plus the threads which tied the urban worker to his sources of food, clothing, and utilities, formed what was called industrial fabric."[13] Additionally, ACTS changed the overall intent of the attacks on the economy from material destruction to functional disorganization and dislocation.[14]

William C. Sherman—while not a member of the ACTS faculty—presaged and influenced the thinking of ACTS with his book, *Air Warfare,* published

in 1926. Sherman introduced nodal-type analysis as a refinement to the systems approach: "Industry consists rather of a *complex system* of interlocking factories, each of which makes only its allotted *part of the whole*. This is an era of specialization. Accordingly, in the majority of industries, it is necessary to *destroy certain elements* of the industry only, in order *to cripple the whole*. These elements may be called the key plants. These will be carefully determined, usually before the outbreak of war" (emphasis added).[15] As with Slessor, ACTS acknowledged that "gathering complete information concerning targets was 'a study for the economist, statistician or technical expert, rather than the soldier.' "[16]

ACTS had as its mechanism the destruction of the enemy's will to resist, which was directly linked to the collapse of the enemy's economy and indirectly linked to the reduction of its military capability. ACTS reasoned that by identifying and disabling a vital common function within the economy shared by both the armed forces and the civil population, such as electrical power, the capacity of the country to sustain itself would be critically weakened and the collective will to resist would collapse.[17]

John A. Warden III

Warden, a retired Air Force colonel, wrote *The Air Campaign* in 1989. Like Douhet, Mitchell, and ACTS, Warden views airpower as potentially decisive. In Warden's theory, airpower's strategic influence is best exercised through indirect attacks against the enemy as a whole system.[18] His primary mechanism is "strategic paralysis," which he argues is induced by disrupting the leadership and command functions of an enemy state.

Warden's targeting strategy built upon the idea of critical system leverage and refined targeting for functional effects established by ACTS's industrial web theory.[19] Warden's construct views an enemy as a whole that can be grouped into five concentric subsystems: a fighting mechanism, population, infrastructure, organic essentials, and leadership.[20] The greatest leverage within this overall system is derived by attacking from inside out, at the innermost ring (leadership), rather than attacking the outermost ring (fielded military forces). In this sense, Warden shares Douhet's notion of avoiding an enemy's fielded forces.

Using Warden's airpower strategy, one would expect the following rationale: defeat hostile will and ability (the objective) by inducing strategic paralysis and economic collapse (the mechanism), caused by isolating leadership and disrupting infrastructure and organic essentials (effects), which are in turn caused by attacking command, control, and communication, and selected industries and utilities (targets).[21] In this sense, Warden's mechanism is similar to that of ACTS (economic stress leading to the enemy's capacity for resistance to collapse) with his addition of stressing the role of leadership and command functions.

Summary

A summary of the airpower theorists in a matrix format is shown in appendix E. The theorists all attempted to answer the question "Where is it best to affect the enemy in order to achieve the greatest effect?" In answering this question, one should evaluate the merit of greatest effect in terms of its influence and linkage to objectives, COGs, leverages, and overall economy of effort. Most of the theorists chose an indirect approach to FA. Their efforts were weighted towards functional effects (second and third order) rather than destruction (first order). Although the key system each advocated attacking varied, the targeting methodology each used to arrive at that decision required a systems approach.

These theories have some universal shortfalls that are an outcome of the inherent complexity, uncertainty, and unpredictable nature of warfare. They tended to overestimate airpower's ability to actually destroy a given target and the functional effects of the physical destruction. Additionally, most theorists underestimated the will of the people to resist, the resilience of economies, and the time required for functional effects to mature.[22] Each strategic theory also assumed that an adversary would possess an infrastructure and economy that was critical to the state's functioning as well as vulnerable to attack.

Two broad FA themes are discernible among the theorists. The first is the emphasis on reducing war will and sustainment by disabling critical functions such as C^2, economic output (power and fuels), or infrastructure (transportation and communication). The second is the idea of attacking the war-making capacity of the adversary by interdicting war supplies at their sources as well as in distribution.

Most of the theorists recognized the need for detailed analysis of the enemy. Slessor, ACTS, and Warden in particular appreciated the requirement for intelligence, in-depth analysis, and outside technical expertise to formulate targeting strategies. An organization that provides that support today for the US armed forces is JWAC.

Joint Warfare Analysis Center

JWAC has some historic precedents in the British Ministry of Economic Warfare (MEW) and the American Committee of Operations Analysts (COA) during the Second World War.[23] MEW specialized in economic intelligence, analysis, and assessment in support of Bomber Command. Gen Henry A. "Hap" Arnold established COA to assess the potential of bombing to reduce the Axis resistance and facilitate the invasion of Europe. The charter of MEW allowed for actual target development, while the COA's more limited charter was confined to target after-action assessment. JWAC was established in May 1994 to provide precision targeting analysis and support to the geographic combatant commanders.[24] JWAC supports planners with in-depth analysis of infrastructure networks, critical

industries, commodities, and military logistics focused on precision targeting and effects. JWAC consists of military personnel, engineers, and scientists. Most of the latter are physical scientists, while the social sciences have a much smaller representation.[25]

JWAC's strength is its ability to generate intelligence on the material basis of an enemy's war effort. As FA weapons have evolved in precision, there has been a parallel need for targeting science to match that precision. JWAC has met that challenge with multisource intelligence and imagery coupled to human and computer-aided analysis to generate *precise* targeting support. However, FA planners should bear in mind that the JWAC analysis is no better than the questions the center is asked and the direction it is given.[26]

JWAC divides its analytical efforts into four main core competencies: electrical power; petroleum, oil, and lubricants; lines of communication; and telecommunications. These four areas collectively focus on *infrastructure networks*. JWAC added three more competencies: critical industries, commodities, and military logistics. JWAC attempts to consider these seven areas as an integrated whole.[27]

The JWAC process starts with a programmed or directed task by a supported combatant commander focused on a specific state, locality, or group. JWAC then assesses the state for potential targets within the seven areas of analysis. The analysis produces targets that are subsequently assessed in terms of potential effects on the state's elements of national power: MPES.

JWAC, like the military in general, seeks to perfect material analysis of an opponent while struggling with nonmaterial analysis. What seems to be missing from the JWAC's analysis is the nonmaterial basis of the adversary—for example, assessments of what the enemy values and an analysis of how the state's government functions.[28]

JWAC's behavioral analysis actually comes after the targets are developed as part of its effects assessment. However, the behavioral analysis ought to be done earlier as an added area supplementing the material analysis in the overall target-generation process. JWAC provides precise material analysis that is system based and focused on targets associated to physical and systemic effects. But because the JWAC does not address nonmaterial analysis, it is unable to generate targets associated with psychological effects (see fig. 8).

Material Analysis	*Linked to*	Nonmaterial Analysis
Structure and Systems		Behavior
Seven Competencies		New Competencies
Physical and Systemic Effects		Psychological Effects

Figure 8. Material and Nonmaterial Analysis

What is missing from JWAC's targeting support is the development of mechanisms to accompany target recommendations. The targeting support to develop mechanisms could be facilitated by adding nonmaterial analysis to the center's current material expertise. The added analysis would provide the needed insight into the behavioral basis of the opponent to link material modification (targets) with behavioral modification (behavior).[29] What is missing from JWAC's product is a rationale for why attacking the targets will influence the opponent's behavior.

An adversary's economy (critical industries and commodities) still merits considerable attention from the FA planner. Olson's work offers some important insights into the complex and adaptive behavior of economies.

Mancur Olson and Economies

The ACTS theory of selective bombing held that by attacking a small part of an industry, one could affect the whole of that industry because of its dependence on the critical part. The dependence could take the form of a resource or a function that the whole required. The concept of key points or bottlenecks within an economy was applied to Germany in the Allies' Combined Bomber Offensive (CBO) during World War II.[30] An example of a bottleneck assessed during the CBO was the manufacturing of ball bearings, thought to be a critical and vulnerable component of German fighter-aircraft production. This assessment proved only half right; by most accounts, ball bearings were critical but only partially vulnerable. The lack of vulnerability was due to a surplus of supply and the resilience of the ball-bearing machinery itself.[31]

Writing in the 1960s, Olson took issue with the basic premise of selective bombing and discussed it in terms of a tactical-supply and a strategic-supply problem. Additionally, he argued that a better metaphor for an economy was a tree rather than a watch. Remarkably, Olson anticipated many of the concepts that are now associated with complexity theory.

Selective Bombing and Nonlinearity

Olson does not reject the idea that selective bombing can yield a disproportionate result. He accepts that FA can yield effects out of proportion to effort. What Olson cautioned was that economies are not as fragile and critically dependent as is often assumed. He pointed out that when considering the criticality of a resource function within an economy, one must make a distinction between the two scales in the economy—tactical and strategic—make a difference in the relative vulnerability of the resource to FA.

Tactical-Supply versus Strategic-Supply Problems

Olson develops the concept that efforts to interrupt a critical-resource function in an economy operate at two different scales.[32] The distinctions Olson makes between a tactical-supply and strategic-supply situation

yield additional insights when placed in the context of tight and loosely coupled systems (see table 6).

Table 6

Tactical-Supply and Strategic-Supply Coupling

Tactical-Supply Situation	*Coupling*	Strategic-Supply Situation
Capacity of operational-level depot to meet supply demand of a front unit.	*Dependency*	Capacity of a nation's entire economy to supply military forces.
Supply is specific; the right kind and amount are required.		Supply is general; kind and amount can be deferred and/or compensated.
Substitution is not an option.	*Slack*	Substitution is an option.
Time is a critical factor.	*Time*	Time is a factor but not critical.

Tight Coupling	*Aspect*	Loose Coupling
Strong dependencies.	*Dependent relationship*	Relative independence from disturbances.
Little give or slack.	*Capacity*	Give and slack exist.
Time-critical.	*Time*	Not time critical.
Disturbances propagate.	*Effects vulnerability*	Relative independence from disturbances.

There is a similarity between a system characterized as tightly coupled and the tactical-supply situation Olson described. FA efforts to affect a tactical-supply situation are likely to be effective because the supply system at that level cannot compensate for the interruption of a critical resource. It cannot compensate because there is a true dependence; there is little or no slack in the system, and there is insufficient time to effect an alternative solution or substitution.

On the other end of the scale, the strategic-supply situation exhibits the characteristics of a loosely coupled system. FA efforts to affect a strategic-supply situation may not be effective because the supply system at that level has an immense capacity to compensate for an interruption of a critical resource. The whole economy can compensate as a system if it has sufficient time to adjust and if excess capacity already exists within the system. Olson points out two areas of strategic success in the CBO: the efforts to disrupt the oil industry and the transportation system. In the case of the oil industry, even before the war, the system exhibited characteristics of a tightly coupled system. Oil was in great demand, and problems with shortages already existed. The system was already stressed, and only limited substitutes were available. In short it was a true bottleneck for the overall economy. The case Olson makes for transportation is more complicated. The German transportation system was not initially stressed but became so by virtue of indirect effects upon it. The indirect effects were produced from demands for transportation to the invasion area as well as the overall demand placed upon transportation due to the dispersion of factories.[33]

In general, logistics are more tightly coupled at the tactical and operational levels than at the strategic level of war. Additionally, it is practically a principle of war that the closer interdiction occurs to the consumer of a supply (and the farther from the source of supply), the sooner the effects of the interdiction will be felt, while the less permanent the interruption will be in the long term.[34]

Ways to Think about Affecting Economies

Olson reasoned that it is fallacious to think of a modern economy in terms of a fragile national industrial structure. The term *structure* falsely evokes something rigid and unchanging. It is misleading to think of an economy as being like a finely jeweled watch because economies, unlike watches, can suffer a loss of a part and continue to function.[35] In short, he argues that economies are not fragile, rigid structures but—to use a later term—*complex adaptive systems*. The analogy he uses is that economies can be likened to trees: for a tree, change is the norm, and adjustment is commonplace. For example, a tree can lose a branch and compensate by growing a new one. FA targeted against an economy may have merit. However, an FA planner would be well advised to keep in mind that economies are not static but dynamic; as such, they have a great capacity to substitute and compensate for disruptions. The system analysis of an economy must identify the industries and functions within it that are tightly coupled and more likely to constitute effective targets.

A Systems Approach to Force Application

System analysis is an accepted part of the overall targeting process for FA. FA theorists in the past have thought of the enemy in terms of vital systems in an effort to discover the most effective means to achieve friendly objectives. Discovering the most effective systems for attack is a difficult undertaking and requires intensive intelligence on the systems composition of an opponent, such as is provided by JWAC.

The value of a systems approach to FA is its development of systems for attack and precise parts of the system to target for the greatest overall effect. However, there are two aspects of systems analysis that could be complemented by an effects-based approach to FA. The first aspect of systems analysis that could be improved is the timing of systems analysis in the overall targeting methodology. An effects-based approach should precede the systems analysis and first develop the effects required to achieve the objectives. Once the effects are planned, then system analysis can develop the systems to attack to produce the desired effects. The second aspect of systems analysis that could be improved is an expansion of the system analysis to consider not only the material basis of an opponent but also its nonmaterial basis.

Effects thinking enhances consideration of the nonmaterial aspects of an enemy and, therefore, better integrates material modification with behavioral modification than does an approach that solely considers material aspects. The principal enhancement that this approach provides is to shift the focus of FA towards desired intermediate results rather than targets. This shift has been expressed as targeting for effect versus targeting for destruction: "In this approach, destruction is used to achieve effects on each of the systems the enemy organization relies on to conduct operations or exert influence—not to destroy the systems, but to prevent them from being used as the adversary wants. Effective control over adversary systems facilitates achieving the political objectives that warrant the use of force."[36] This distinction is similar to the difference between being told what to do and how to do it. Emphasis on effects rather than targets should open up greater possibilities for influencing the enemy and reframe the perspective on targets to one of means rather than ends. This should facilitate an approach that deemphasizes targeting for destruction (first-order effects) and accents targeting for influence (second-order effects).

Systems analysis, as practiced by JWAC, does consider effects when it assesses target effects on national elements of power. However, the issue is one of emphasis: the system-analysis process does not emphasize assessing effects. The real core competency of systems analysis is understanding a system in detail in order to affect it efficiently. The value that effects analysis offers is understanding a system's relationships to other systems in detail in order to affect it effectively. It takes both approaches to develop a complete perspective. Seen another way, the distinction between the two approaches can be stated in terms of impact assessment and targets. Systems analysis says, "Choose a desired target and then look at the effects of striking that target." Effects analysis says, "Choose a desired effect and then look at targets to achieve that result."

Summary

The work of the four airpower theorists supports the value of thinking of the enemy as a whole and in terms of systems. They all appreciated the need for detailed analysis of the opponent. The vital systems they identified and the mechanisms accompanying them are an important reference for modern-day FA planners.

Systems analysis is a valuable tool for FA planners. Organizations such as the JWAC are able to provide in-depth targeting analysis and recommendations using a systems approach. JWAC's strength is generating targets based on material analysis of an enemy's war effort. This analysis should be supplemented with a nonmaterial analysis in order to develop mechanisms that link targets to desired behavioral changes. Additionally, a systems analysis could be complemented by a prior effects-based analysis that develops intermediate effects to achieve the directed objectives.

Once the desired effects are developed, then a systems analysis can develop the targets that will, in turn, generate the intended effects.

Because of the widespread interest in economies as systems for attack, the ideas of Olson on the resilience of economies are valuable to FA planners. He pointed out that when considering the criticality and vulnerability of a resource function within an economy, one must know whether the resource is part of a strategic or tactical level of the economy. The two scales of an economy make a profound difference in the effectiveness of the FA.

Notes

1. Joint Publication (JP) 3-0, *Doctrine for Joint Operations*, 1 February 1995, III-17.

2. Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (Washington, D.C.: Government Printing Office [GPO], 1983), 57. Notice that Douhet is advocating essentially an indirect approach focused on functional essentials of an opponent (supply, transportation, fuel, and airfields).

3. Ibid., 22, 25, 126, and 277–81.

4. This unconstrained environment allowed both Douhet and Mitchell to see attacks on civilian population centers as just another option for influence. This lack of constraint, coupled with a belief in the moral fragility of societies, led to a perception that whole nations could be morally unhinged by attacking cities—a shortcut to reducing total resistance (total means times will) on the will side of the equation.

5. William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power—Economic and Military* (New York: Dover Publications, 1988), 127.

6. School of Advanced Airpower Studies (SAAS) lecture notes on "Mitchell" for course 631, Phillip S. Meilinger, Maxwell AFB, Ala., 1993.

7. J. C. Slessor, *Air Power and Armies* (London: Oxford University Press, 1936), 68.

8. Ibid., 89.

9. Ibid., 66.

10. Ibid., 63.

11. Thomas A. Fabyanic, "Strategic Air Attack in the United States Air Force: A Case Study," Air War College paper (Maxwell AFB, Ala., Air University, 1976), 43.

12. Ibid., 33. This entire paragraph is from this source.

13. Quoted in "Principles of War Applied to Air Force Action" (Maxwell Field, Ala.: Air Corps Tactical School [ACTS], 1934–1935), 2–3.

14. Fabyanic, 34.

15. William C. Sherman, *Air Warfare* (New York: Ronald Aeronautic Library, 1926), 218.

16. Fabyanic, 41; and "Air Force: National Economic Structure" (Maxwell Field, Ala.: ACTS, 1938–1939), 11.

17. Fabyanic, 42; and Alfred C. Mierzejewski, *The Collapse of the German War Economy, 1944–1945* (Chapel Hill, N.C.: University of North Carolina Press, 1988), 80–85. Mierzejewski describes an example of assessing a common vital function between the armed forces and a civilian population.

18. John A. Warden III, "The Enemy as a System," in *Concepts in Airpower for the Campaign Planner*, ed. Albert U. Mitchum (Maxwell AFB, Ala.: Air Command and Staff College, 1993), 6.

19. The similarity in the theories (ACTS's and Warden's) is that they both are seeking functional effects. ACTS's targeting philosophy seeks to functionally collapse an enemy's economy, and Warden's philosophy seeks to functionally disrupt command and control elements, which leads to strategic paralysis.

20. Warden, 15–17.

21. Ibid., 17.

22. The exceptions are that Douhet did not consider economies and that Slessor did not consider the will of the people.

23. R. J. Overy, *The Air War, 1939–1945* (Chelsea, Mich.: Scarborough House, 1980), 110–12; and Alan J. Levine, *The Strategic Bombing of Germany, 1940–1945* (Westport, Conn.: Praeger, 1992), MEW, 37–38, 55, 162, 186 and COA, 85–86.

24. JWAC was derived from the Naval Warfare Analysis Center, established in June 1993. JWAC is organized under Joint Operations (J3) and the J-39 Directorate.

25. Pat "Curly" Pence, "JWAC Overview," briefing slides, SAAS, Maxwell AFB, Ala., 3 December 1997; and James N. Rosenau, "Many Da-- Things Simultaneously: Complexity Theory and World Affairs," in *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski (Washington, D.C.: National Defense University, June 1997). Rosenau has this to say about reconciling the two science disciplines: "Our conceptual equipment needs to be enhanced and refined, that under some conditions non-linear approaches are more suitable than the linear conceptual equipment that has served for so long as the basis of analysis, that the disciplinary boundaries that have separated the social sciences from each other and from the hard sciences are no longer clear-cut, and that the route to understanding and sound policy initiatives has to be traversed through interdisciplinary undertakings" (78).

26. Rosenau, 78.

27. Ibid.

28. A longer list of what a nonmaterial analysis of an adversary might include is mind-set, stakes, interests, decision-making processes, third parties, domestic politics and policies, alliances, chain of command, succession, security of elite, propaganda devices, and population and dissidence control.

29. It is interesting, however, to speculate on where a complete analysis might be accomplished. It appears that no one body has all the intellectual resources, input, and guidance it needs to do a holistic analysis of an adversary for FA. A short list of the main bodies required for an analysis would include policy, intelligence, and material specialists, as well as behavioral specialists and capability experts. Policy guidance would be given by the president or secretary of defense, JCS, and/or the combatant commanders. Intelligence would include all the major intelligence agencies, with an emphasis on imagery and assessment. Material specialists include representatives from the hard sciences, essentially the composition of JWAC now. Behavioral experts would include political scientists, psychologists, social scientists, and individuals specializing in regional studies and cultures. FA operators serving on operational staffs, such as numbered air forces and division-level J-3s, would provide capability expertise. The point of all this speculation is that no one group has all the pieces, but that all the pieces are needed to form a coherent and whole strategy for influencing an adversary to our objectives.

30. Mancur Olson Jr., "The Economics of Target Selection for the Combined Bomber Offensive," *Royal United Services Institute Journal* 107 (November 1962): 308; and idem, *The Economics of the Wartime Shortage* (Durham, N.C.: Duke University Press, 1963), 137–46.

31. Alan J. Levine, *The Strategic Bombing of Germany, 1940–1945* (Westport, Conn.: Praeger, 1992), 106; and Williamson Murray, *Strategy for Defeat: The Luftwaffe, 1933–1945* (Maxwell AFB, Ala.: Air University Press, 1983), 171.

32. Olson, 310–11.

33. Ibid., 313. See also Mierzejewski, 177–87.

34. JP 3-03, *Doctrine for Joint Interdiction Operations*, 10 April 1997, vi; and Eduard Mark, *Aerial Interdiction: Air Power and the Land Battle in Three American Wars* (Washington, D.C.: GPO, 1994), 148–51.

35. Olson, 312.

36. David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995), 8, also 4–5 and 9.

Chapter 4

Effects: Applicability, Complexity, and Planning

Beyond the activity of destroying an opposing force lies the ultimate purpose of combat: to compel an opponent to act according to desired behavior. An effects-based strategy would employ force to control rather than destroy the opponent's ability to act. . . . Using force to achieve specific effects against portions of a system that render the entire system ineffective yields control over that system.

—Rebecca Grant
Origins of the Deep Attack Weapons Mix Study

Compelling an adversary to modify his behavior in accordance with one's objectives is a basic goal of war. Operational art uses FA as its primary means to influence an adversary's behavior. Traditionally, the focus of FA has been on targets; this study proposes a shift in concentration to effects. Effects are not new to FA, but a process to plan for them deliberately in advance of selecting targets is new. An effects-based approach deliberately links effects to objectives and promises greater effectiveness and economy of effort than does a targets-based approach.

It is important to note that achieving effects does not necessarily imply effectiveness. The difference between effects and effectiveness, as well as how effects fit into an assessment of effectiveness, is discussed in this chapter. Additionally, effectiveness is examined in the framework of an effects-based approach using the FA-process model.

Effects that result from attacks on interconnected and interactive systems are complex and are usually difficult to predict. This chapter develops propositions to enhance FA planners' abilities to understand such complex system effects.

Focusing on Effects

Although changing a mind-set is never an easy task, developing the habit of thinking in terms of effects can be of great use to FA planners. The principal benefits that an effects-based approach provides is to keep objectives first in mind and to develop a perspective that views targets as merely a means to those ends.

Virtual Attrition versus Attrition and Annihilation

One of the premises of an effects-based approach to warfare is that it may not be necessary to influence an opponent solely through a strategy of annihilation or attrition.[1] A greater economy in overall effort may be

achieved by employing a strategy of "virtual attrition." The strategies of annihilation and attrition have long been standard war-fighting concepts.[2] An annihilation strategy seeks to defeat an enemy outright, essentially winning victory through physical elimination of any opposition. Attrition relies on superior maneuver and selective battles as a more protracted means of defeating an opponent over time.[3] Importantly, both strategies rely on destruction as their operative means to victory. This has a tendency to lead to destruction's becoming an end in itself, instead of a means to an end.

An alternative to a reliance on annihilation or attrition is a strategy of virtual attrition, which is a derivative of attrition: maneuver is still used with FA. However, virtual attrition uses destruction to generate functional effects to bring about its attrition. Virtual attrition shifts the focus from destruction to the effects of destruction, which in turn influence an opponent to modify his behavior. In 1995 Col David A. Deptula saw this influence in terms of control: "Well beyond the activity of destroying an opposing force lies the ultimate purpose of war—to compel a result. Use of force to control rather than destroy an opponent's ability to act lends a different perspective to the most effective use of force."[4] In this strategy, targets are struck not as ends in themselves but rather as a means of influence.[5] This can take the form of a functional effect such as controlling, delaying, disrupting, diverting, or neutralizing some aspect or function of an opponent, without necessarily inflicting great physical destruction. An example of virtual attrition is Lt Col James H. Doolittle's raid on Tokyo during the Second World War. The raid caused very little actual physical damage, but "the second-order psychological and strategic consequences of the April attack on the Japanese home islands by Doolittle's sixteen B-25s were far-reaching and profound."[6] The raid resulted in Japanese leaders' loss of face, the diversion of Japanese forces, and the ill-fated Japanese strategy to seize Midway.

Effects versus Targets

The shift in focus from targets to effects forces planners to look beyond destruction to the all-important consideration of what will result from that destruction. This idea of projecting forward, viewed from the perspective of the FA-process chain, inserts effects as a planning consideration before targets (see fig. 9). The planner first determines the mechanism—the "who" and "what" to be influenced—then identifies the effects that will trigger it. Once the desired effects are determined, the process can move to assessing what targets can be acted on to generate them. This overall process now describes a chain of events—where targets are struck to generate effects—which influence objects within the selected mechanism in order to fulfill the objectives.

Planning →

Outcome	Mechanism	Effect	Target	Action
Objectives; desired ultimate results; end state	Rationale; object of effects; who and what	Results; intermediate objectives	Object (of force application)	Weapon and weapon platform

← Execution

Figure 9. Chain of the Force-Application Planning Process

Second-Order Effects versus First-Order Effects

Second-order effects are the results of first-order effects. Destruction is the most common first-order effect associated with FA. However, a critical component within a system may be struck not merely to achieve the material destruction of that component but for the effect of the component's destruction upon the parent system.[7] The second-order effect, in this case, is disrupting or perhaps even disabling the function of the overall system for some period of time. The system in its entirety need not be utterly destroyed if it is possible to achieve the same desired outcome through virtual attrition.[8] An example of functionally disrupting an entire system can be drawn from the Gulf War of 1991. During the first two days of the war, 11 power plants and seven transformer/switching facilities were struck. These selective attacks on key nodes of the Iraqi electrical power (EP) grid resulted in a 60 percent reduction of its power capacity. The actual physical damage to the Iraqi EP infrastructure was limited and modest; however, the functional effects of this limited destruction were pervasive and profound.[9]

If something is bombed only to destroy it, essentially an exchange of bomb for object, then a proportionate outcome is being sought. This type of thinking is closely associated with the strategies of annihilation and attrition with their focus on destruction as an end. A better exchange would be one bomb affecting many objects (or a complete system) as a result of the targeted object's destruction. This exchange would be a nonlinear and disproportionate outcome. In this case, FA—by virtue of the second-order effects generated from the destruction of the target—has leveraged its exchange. Such leverage, if it occurs at all from a weapon to target exchange, usually occurs as a second-order effect. Hence, leverage implies targeting for influence beyond mere destruction of the target.

Targeting for Influence

FA can be seen as having two basic targeting strategies: one target-based, the other effects-based (see fig. 10).[10] Given sufficient time to be proactive, an effects-based targeting philosophy has a better chance of being effective. This may seem obvious, but this planning strategy is not always followed,

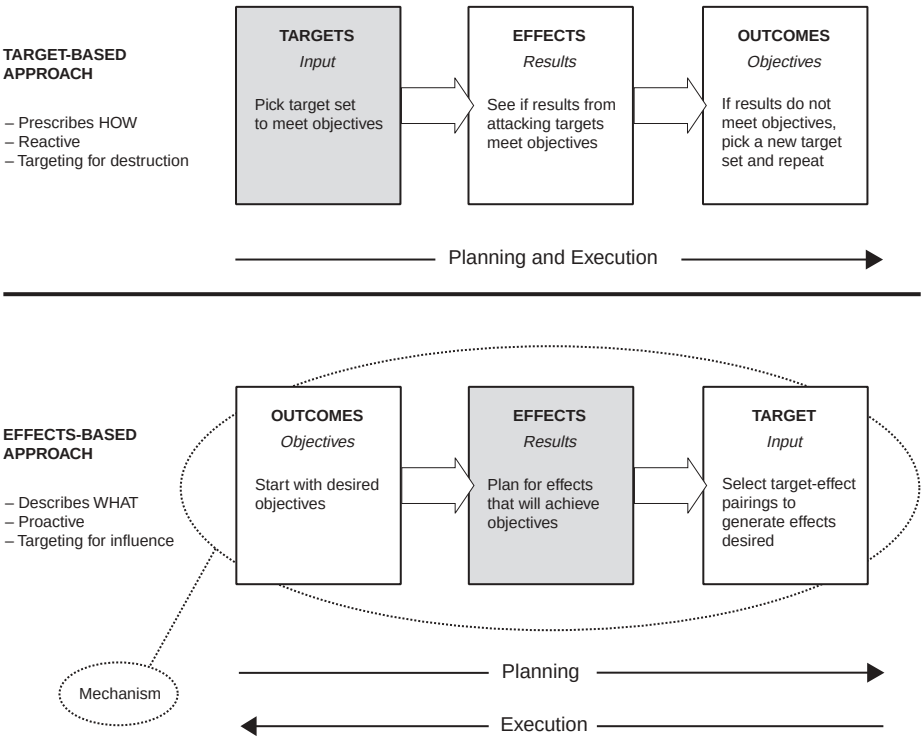


Figure 10. Target-Based versus Effects-Based Approaches to Force Application

due either to habit and or a lack of available time to assess and plan. However, sometimes it is imperative to react and eliminate threatening targets without concern for second-order effects. As an example, in 1990—during Iraq's invasion of Kuwait—if the Iraqis had proceeded down the coast into Saudi Arabia, it would have been imperative to stop them.

Effects and Effectiveness

Thinking in terms of effects linked to objectives should theoretically be more effective than thinking in terms of targets and then taking whatever results come from their destruction. There are no certainties in either case, but planning for effects usually enhances the probability of achieving those effects and their linked objectives. This is what an effects-based targeting philosophy aims for: to increase the likelihood, through deliberate planning, of accomplishing the objectives by achieving linked effects.

Individual FAs are planned with the intent to effect specific outcomes. A suitable term to distinguish discrete FAs that have been planned to achieve specific outcomes is an *FA set.* In order for an individual FA set to be effective, its FA-process chain of target-to-effect-to-objective must maintain its coherence. This coherence is upheld if a given target generates the desired effects, which in turn translate to influencing the associated objective (see fig. 11).

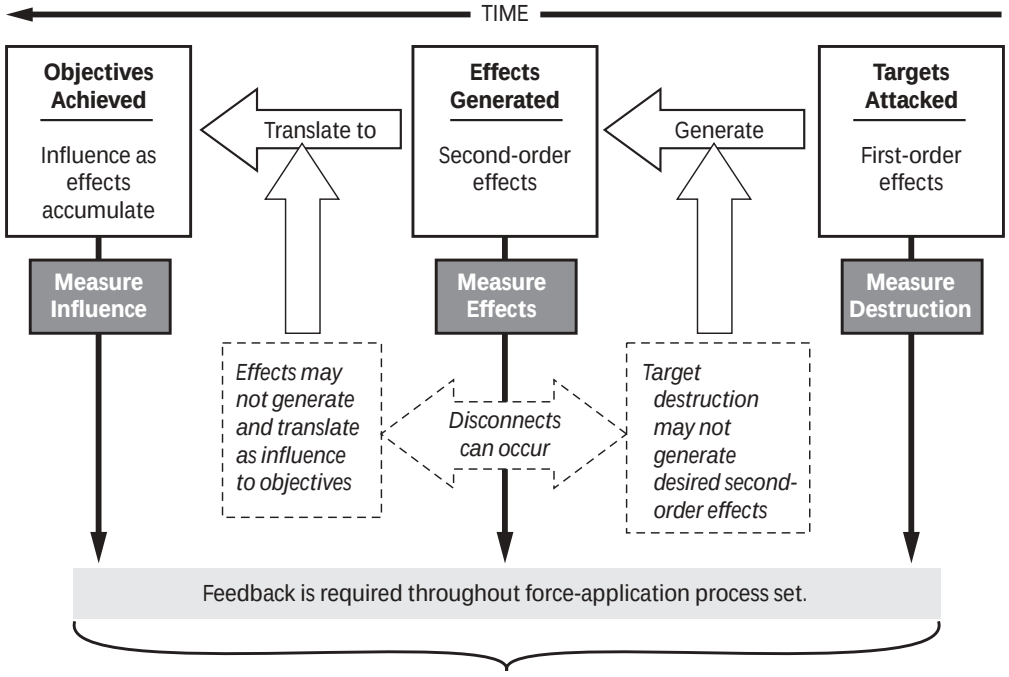


Figure 11. Effectiveness

Effectiveness

There is obviously a difference between effects and effectiveness.[11] FA effects consist of first-order and second-order resultants generated from a given attack. Effectiveness is achieved to the degree that the effects actually achieve the intended objectives. The distinction between effects and effectiveness is that effects may be generated from a given attack, but if they do not contribute to the accomplishment of the objective, they are not effective.

A concern with effects and effectiveness is found throughout the services but has been particularly prominent for airpower. This stems from airpower's propensity to operate at the operational and strategic levels of war and the increased difficulty of measuring effects and effectiveness as one moves from the tactical to the strategic level of war.[12] Jervis addresses this difficulty in measuring effects as one progresses from simple to more complex systems:

> Looking at a single yardstick to measure success in a complex system is likely to mislead because it fails to capture the multiple and indirect effects that will become increasingly important as the system reacts to the actor's behavior. . . . Because effectiveness can rarely be gauged directly, surrogate measures are required. Usually, these take the form of enemy forces that have been destroyed or shortfalls in enemy military production. But looking only at these obvious effects ignores "virtual attrition"—the reduction in effectiveness of enemy forces or the diversion of resources that is required for the enemy to cope with your efforts.[13]

Objectives at the tactical level of war and, to a lesser extent, the operational level tend to focus on territory and numbers of forces. On the other hand, objectives associated with the strategic level of war tend to be more abstract. An example of a strategic objective is to reduce the enemy's ability to sustain war and his willingness to continue war. In a sense—to draw upon an earlier distinction—tactical and operational objectives tend to involve forces, and strategic objectives tend to involve functions.[14]

Measurement of Effects

Feedback is required throughout the entire process of FA in order to determine its effectiveness. In simple terms, there are three levels at which to measure the effects and effectiveness of a given application of force (see fig. 11). The first is the actual physical destruction to the target resulting from the weapon effects. This captures the first-order effect upon the target. The second is an attempt to capture all of the indirect or second-order effects generated from the initial destruction of the target. This measurement is far more difficult because these may be functional, systemic, or even psychological effects. As effects move from physical to systemic to psychological, their material basis decreases and with it their direct measurability. Figure 12 illustrates the concept that effects tend to become increasingly difficult to measure as they move from first order to second order and as they become more delayed in time. The effects can still be captured, but the measuring efforts shift from a reliance on imagery (physical effects) to indicators of systemic effects and human intelligence (HUMINT) for the psychological assessment. An example of an indicator for measuring systemic effects would be monitoring a sector for loss of power following an attack on an EP transformer station, the loss of power being an effectiveness indicator.[15]

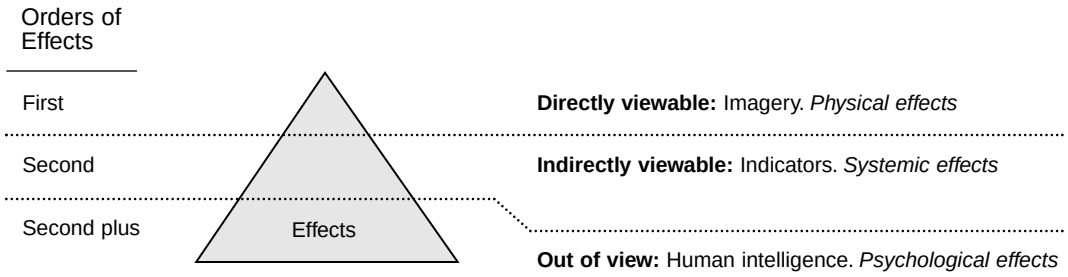


Figure 12. Efforts to Measure Effects

The third measurement is the most difficult and is really more of an assessment that attempts to determine if FA contributed to the achievement of its planned objective. This is an important determination to make in order to regulate future FA efforts. If the effects are not contributing positively to the accomplishment of the objective, then they need to be adjusted. The principal adjustment is to change the targets to produce

new effects that will have a better probability of fulfilling the objective. However, this assessment is problematic because determining whether the effects themselves or their planned influence is faulty is very difficult.[16]

Disconnects

There are two principal disconnects that can occur at the seams in the FA process as the effects generate and time elapses (shown in fig. 10). After the target is initially struck (assuming that the intended destruction occurs), the first-order effect may not generate the intended second-order effects. Obviously, this disconnect would arrest the overall process of influence, and the physical destruction would be the only result.[17] The second disconnect can occur (assuming that the second-order effects have occurred) if the generated effects do not actually influence or fulfill their intended objectives.

This complex nature and unpredictability of effects are due, in part, to their interconnective and interactive character. The next section explores this complexity in an effort to gain insight and develop some general propositions regarding the nature of effects.

Simple and Complex System Effects

The purpose of this section is to expand thinking on effects with particular attention to system effects. Specifically, the 1997 publication—*System Effects: Complexity in Political and Social Life*—by Robert Jervis is examined in an attempt to derive propositions applicable to FA.

A key aspect of Jervis's work is the premise that the nature of effects intended from actions against a system is closely related to the nature of that system. Therefore, by understanding a system's nature, one can gain insight into the nature of cause-and-effect that will result from actions (force application) taken against that system. An additional premise of Jervis's work is that the nature of complex systems is closely related to principles associated with complexity theory: a propensity for nonlinear systems to generate disproportionate effects and for the sum of those effects to be greater or less than the whole.

Complex systems exhibit high degrees of interconnectivity and interaction (see table 7). They are usually intricate structures in terms both of internal structure and outside linkages to other systems.[18] The example Jervis frequently uses is the most complex system of all—that of a state within the international system.

Because of the complexity of complex systems, disturbances to them are usually characterized as having long cause-and-effect trains.[19] The length of these trains and the complexity of interactions within the system produce additional properties of complex systems. Actions taken against a complex system can yield both unintended and delayed effects.[20]

Table 7

Simple and Complex Systems

Simple Systems	Complex Systems
Low interconnectivity and interaction	High interconnectivity and interaction
Basic structures	Intricate structures
Short cause-and-effect chains	Long cause-and-effect chains
High predictability	Low predictability
Straightforward effects	Perverse (complex) effects
Effects are usually immediate	Effects are often delayed
Proportionate effects (linearity)	Disproportionate effects (nonlinearity)
Effects are additive	Effects are greater or lesser than sum
Lesser chance of unintended consequences	Higher chance of unintended consequences
Outcomes usually match intentions	Outcomes do not necessarily match intentions
Isolated systems (intrasystemic)	Interrelated systems (exosystemic)

Planned effects from attacking a complex system are relatively uncertain due to the increased number and frequency of interactions.[21]

In contrast, simple systems are linear and conform to the principles of proportionality and additivity.[22] Simple systems exhibit low interactivity and few interconnections. Additionally, they are usually basic structures and are isolated from other systems. Examples of simple systems include oil pipelines, isolated military units, decentralized man-portable air defense systems, and bridges.

Because of the relative simplicity of simple systems, disturbances to them can be characterized as possessing short cause-and-effect trains.[23] Actions directed at a simple system usually generate both intended and immediate effects. Because the effects derived from simple systems are usually straightforward in nature, a fair degree of predictability can be associated with simple systems, and planned effects enjoy a greater degree of certainty than do those planned versus complex systems.

It is important to point out that Jervis does not argue that effects will be either complex or simple.[24] Instead he argues that both simple and complex effects can derive from the same system, again in keeping with nonlinearity and complexity theory. As counsel that planning for effects is still possible, Jervis observes that “while the complex interactions in a system mean that some of the consequences will be unintended and undesired, it is hard to measure their frequency. As Albert Hirschman has stressed straightforward effects are common and often dominate perverse ones. If this were not the case, it would be hard to see how society, progress, or any stable human interaction could develop.”[25] “Although thinking in terms of one-way, linear, and additive processes often misleads, it is unlikely that we could have come to see the world in these terms if this was never appropriate. . . . Action can be effective in the face of complex interactions; a systems approach need not induce [planning] paralysis.”[26]

Planning for Effects

There is a tension in this study between two different views of cause-and-effect relationships. On the one hand, cause and effect is held up as nonlinear, highly interactive, disproportionate, and complex. The other view of cause-and-effect relationships is presented as linear, serial, proportionate, and simple. In this linear view, one can plan for cause and effect, given enough information beforehand to describe the initial conditions.

These two views on cause and effect (linear and nonlinear) in a wider sense can be seen as the tension described in chapter 1 between the established Newtonian framework and the emerging framework reflected in complexity theory. Jervis also suggested that this is the same tension as the one between simple and complex systems.[27]

This question of which characterization of cause and effect is most appropriate to war is important for the FA planner. In essence, one should ask if it is possible to plan for effects and then achieve them. There is no absolute certainty with any FA taken to induce a planned effect. However, it is possible for FA planners to organize expectations concerning effects based on the complexity of the system attacked and the complexity of the intended effect. This understanding develops a comprehension of risk that FA planners need to take into account when weighing the value of various attack schemes.

This study asserts that some target-effect pairings are less uncertain than others; there are highly probable and less probable FA sets. Annihilation can be said to have a relatively simple cause-and-effect chain: destruction to cause elimination. Virtual attrition, however, has a relatively complex cause-and-effect chain: the use of destruction to cause second-order effects, which in turn influence the enemy's behavior (see table 8).

Examples of these strategies and cause-and-effect chains were observed during the Gulf War of 1991. A strategy of attrition was used to reduce the Iraqi armor in Kuwait and southeast Iraq prior to the ground war. The coalition strategy called for the elimination of Iraqi armor and

Table 8

Simple and Complex Target-Effect Pairings

Simple Target-Effect Pairings	*Associations*	Complex Target-Effect Pairings
Direct effects/First order	*Effect and order*	Indirect effects/Second order and higher order
Elimination	*Mechanism*	Influence
Annihilation and attrition	*Strategy*	Virtual attrition
High predictability	*Predictability*	Low predictability
Low effects risk	*Risk*	High effects risk
Low to moderate payoffs	*Benefit*	Moderate to high payoffs

artillery by 50 percent. This was a straightforward and linear proposition—to destroy Iraqi armor and artillery using direct and proportional effects. Measuring the objective of reducing Iraqi combat effectiveness was to be equally straightforward—simply counting the destroyed equipment. This strategy and objective by most accounts succeeded, although there is still debate on the starting numbers of equipment and total numbers destroyed prior to the ground war.[28]

A strategy of virtual attrition was also used in the Gulf War in an attempt "to disrupt the 'central nervous system' of Saddam Hussein's Ba'athist regime."[29] The target categories selected to achieve this objective were Iraqi C^3 and leadership. Coalition planners reasoned that if they could sufficiently disrupt Saddam's ability to control his military forces, then Iraq would not be able to respond effectively to coalition initiatives. This was a more complex and nonlinear proposition, calling for the destruction of key targets to create disproportionate effects resulting in C^2 paralysis. This strategy and objective was not as successful as hoped for, due in part to the complexity, resilience, and redundancy of the Iraqi C^3 system.[30]

Summary

By deliberately planning to achieve effects, FA planners can enhance the overall effectiveness of their efforts. This enhanced effectiveness is achieved by working out in advance the target-effect pairings that make the best sense for accomplishing objectives.[31]

Effects will always contain an element of uncertainty, but this uncertainty can be partially anticipated based on the complexity of the system attacked. An FA planner who knows that an attack on a complex system is required must plan carefully to determine its vulnerability. Additionally, an FA planner who knows the resilience of complex systems should anticipate that multiple attacks may be required to achieve the desired effects.

In general, the more complex the system attacked and the more complex the effect desired, the less certain the desired outcome. A strategy of virtual attrition requires attacks on complex systems and the production of sophisticated functional effects. Because of this complexity, repeated attacks may be required to generate the desired effects. However, some effects are not achievable, and an FA planner must be prepared to judge the difference between persisting to eventual success and reinforcing failure. An FA planner should balance the overall FA efforts between simple and complex effects as well as between pragmatic strategies such as attrition and the more idealistic strategy of virtual attrition. In keeping with this perspective, this study embraces both approaches to target-effect pairings, simple and complex. This combined approach is consistent with not excluding a strategy of either attrition or virtual attrition but recognizing a potential for both.[32]

Before exploring target-effect pairings in greater depth, one must develop a more specific sense of effects. Chapter 5 develops some of the fundamental properties of effects, including effect orders and time-related propositions. It also examines unintended effects as a consequence of FA. Additionally, in an effort to equip FA planners with useful guides for planning effects, it develops various organizational schemes for classifying effects.

Notes

1. David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995), 8.

2. Gordon A. Craig, "Delbruck: The Military Historian," in *Makers of Modern Strategy*, ed. Peter Paret (Princeton, N.J.: Princeton University Press, 1986), 341–42. Delbruck refers to the two strategies as annihilation and exhaustion. Delbruck's strategy of exhaustion is interpreted by the author as being synonymous with attrition.

3. Deptula, 8. See also David S. Fadok, *John Boyd and John Warden: Air Power's Quest for Strategic Paralysis* (Maxwell AFB, Ala.: Air University Press, 1995), 9; and Jason B. Barlow, *Strategic Paralysis: An Airpower Theory for the Present* (Maxwell AFB, Ala.: Air University Press, 1994), 11–12. Both Fadok and Barlow argue that strategic paralysis is a new strategy of warfare distinct from annihilation and attrition. Fadok's and Barlow's arguments have some similarity to the author's on virtual attrition; the similarity lies primarily in arguing for a potential new strategy.

4. Deptula, 4.

5. Ibid., 8–9.

6. *Gulf War Air Power Survey* (*GWAPS*), vol. 2, *Operations and Effects and Effectiveness*, pt. 2, "Effects and Effectiveness" (Washington, D.C.: Government Printing Office, 1993), 51–53.

7. Deptula, 16–17.

8. Ibid., 5. "Force used to effectively control a system rather than destroy it, may lead to the same operationally relevant result, but with much less use of force."

9. *GWAPS*, 294–95 and 302–3.

10. Steven M. Rinaldi, *Beyond the Industrial Web: Economic Synergies and Targeting Methodologies* (Maxwell AFB, Ala.: Air University Press, 1995). The basic philosophies and models have been taken from this work. The emphasis and titling within the models have been modified to better fit this study's intent and interest. Rinaldi calls his models "input" (target) based and output or "objective" (effects) based. A primary premise of this study is that effects can be thought of as intermediate objectives—hence, this study's interpretation of the output model as directly associative to an effects model.

11. *GWAPS*, 25–75. This section, titled "How to Think about Effects and Effectiveness in Desert Storm," discusses the distinction between effects and effectiveness and the difficulty with capturing and measuring effects. The survey suggests that effectiveness becomes more problematic as one pursues objectives associated with the operational and strategic levels of war. This difficulty may be due to the increasing complexity and abstraction of objectives as they move principally from material to behavioral influence.

12. Air Force Doctrine Document 1, *Air Force Basic Doctrine*, September 1997, 40.

13. Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, N.J.: Princeton University Press, 1997), 89.

14. *GWAPS*, 48–51.

15. Ibid., 37. This reference discusses some of the problems associated with measuring functional effects.

16. This appraisal, particularly for airpower, has been historically problematic. More than 50 years after the fact, the debate continues concerning the efficacy of strategic

bombing in World War II. Military literature is replete with arguments for both airpower's being decisive and its being wasted in the Combined Bomber Offensive.

17. This is not meant to imply that destruction is never a sufficient effect. What is meant is that if the destruction is intended to generate an effect beyond itself and it does not, then the overall action has not been effective because the second-order effect did not occur.

18. Jervis, 9, 17, 21, and 29.

19. Ibid., 20–21.

20. Ibid., 29, 61, and 65.

21. Ibid., 6 and 9. However, actions taken against a complex system cut two ways. The nature of complex systems with their high degree of interconnectiveness and interactivity cuts FA on both sides of the effectiveness quotient. On the one hand, effects risk in complex systems is high; FA efforts to actualize desired effects upon them may not materialize because of their complexity. On the other hand, their payoff function is high; due again to their highly interconnective nature, the potential to realize distributed effects across several interconnected systems is high.

22. See the "Summary" in chap. 2. Linear systems conform to two main principles—those of proportionality and additivity. The principle of proportionality states that changes in system output are proportional to changes in system input, and additivity states that the whole is equal to the sum of its parts.

23. Ibid., 20.

24. This line of thought suggests that the real purpose of thinking in terms of simple and complex systems is to derive some general guidelines for understanding the possibilities for effects in terms of this general codification. As with most phenomena, there are not a lot of hard-and-fast rules. The system characterization (of simple and complex) is offered as a construct and a guide to expand thinking on effects and to generate additional insights.

25. Jervis, 67.

26. Ibid., 260–61.

27. This tension, restated, describes a duality between cause-and-effect determinism (Newtonian) and cause-and-effect probabilities and trends (complexity). Lt Col Robert P. Pellegrini, USA, *The Links between Science, Philosophy, and Military Theory: Understanding the Past, Implications for the Future* (Maxwell AFB, Ala.: Air University Press, 1997), v, 42–45; see also Barry D. Watts, *The Foundations of US Air Doctrine: The Problem of Friction in War* (Maxwell AFB, Ala.: Air University Press, 1984), 105–21.

28. Thomas A. Keaney and Eliot A. Cohen, *Revolution in Warfare? Air Power in the Persian Gulf* (Annapolis, Md.: Naval Institute Press, 1995), 89–94. Additional debate concerns whether or not the planned 50 percent attrition was achieved. Gen H. Norman Schwarzkopf suspended the measure of effectiveness of tying numbers loss to effectiveness in favor of one allowing a more subjective overall assessment.

29. Ibid., 57–61.

30. Ibid., 59–60.

31. Chap. 6 attempts to develop both target-effect pairings and the implied mechanisms that can be associated with them by examining the work of several theorists and other sources.

32. If the strategies compete, they should be arbitrated based on the best means available and overall economy of effort to deliver the desired effects. In other words, what option looks best, considering the trade-offs between effects risk and benefits (plus opportunity cost), given the requirement for greatest economy of force and the limitations of time and forces available.

Chapter 5

A Primer on Effects

> *For want of a nail the shoe was lost, For want of a shoe the horse was lost, For the want of a horse the rider was lost, For the want of the rider the battle was lost, For the want of a battle the kingdom was lost—All for a horseshoe nail.*
>
> —Benjamin Franklin
> *Poor Richard's Almanac*

Benjamin Franklin is describing a golden effect—an 1800s version of a "golden BB"—which is a tightly coupled system vulnerable to perfect FA leverage (nonlinearity in action), a dream sequence of cause and effect. It would be impossible to foresee this sequence in advance, but FA planners can anticipate other chains.

This chapter expands on the discussion of the general properties of effects and develops several schemes to organize and classify them. These will aid the FA planner in determining which effects to plan for to achieve objectives and in anticipating what effects to expect from various FA sets. The schemes advanced in this primer will be used later as evaluative criteria to develop and evaluate the target-effect pairings and mechanisms of various FA sources in chapter 6.

Properties of Effects

Before classifying effects, it is helpful first to understand some of their general properties. A basic distinction among effects is whether they are first or second order—that is, direct or indirect. Additionally, effects can be described in three dimensions of time: their effect rate, their development period, and their duration. Some effects are planned or intended, while others are unintended. When detected, unintended effects must be evaluated for their overall impact on intended effects and objectives.

First-Order and Second-Order Effects

This study considers first-order effects synonymous with direct effects. Second-order effects are synonymous with indirect effects (see fig. 13).

First-Order (Direct) Effects. First-order effects in FA are those that result immediately from the action of the weapon upon the target. The term *direct* refers to results that are directly attributable to the destruction of the target and that occur immediately (or very nearly immediately) after the physical destruction of the target.

Second-Order (Indirect) Effects. Second-order effects occur after the initial first-order event.[1] Second-order effects have been referred to as *downstream resultants* stemming from first-order effects. This reference is

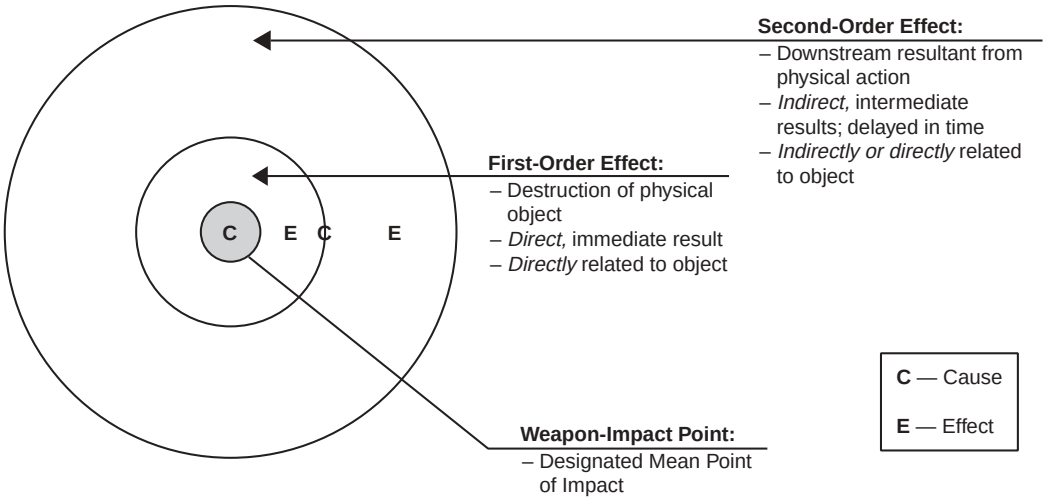


Figure 13. First-Order and Second-Order Effects

particularly apt because it captures the sense of second-order effects being related to first-order effects (part of a stream) and yet unrelated in time.

Targets are usually struck as a means to affect something other than just the target. This is usually a desired second-order effect upon a parent system of the target. Second-order effects usually have some kind of systemic influence. This can be intrasystemic, affecting the parent system that the target component is part of, or can progress to affecting an outside system. A systemic effect that affects an outside system (exosystemic effect) is really a third-order effect.

Examples of Effect Orders. A simple example of first-order and second-order cause and effect occurs in artillery bombardment. The first-order effect is the destruction directly wrought by the shells against men and equipment. Second-order effects include the destruction's causing men to keep their heads down, as well as generating shock, fear, fatigue, and perhaps even demoralization. Other examples are shown in figure 14.

Temporal Qualities of Effects

An FA planner using an effects-based approach plans from his or her objectives to the effects desired, using effects as a means to fulfill the objectives. Effects vary in the time it takes them to mature to their designed levels of influence and in their duration. Some effects are intended to have short lives, often just first-order destruction. Others have intermediate lives—when aimed at affecting a parent system—while still others are intended to have long lives, progressing from destruction to affecting a parent system to affecting other connected systems. Normally, the longer the cause and effect to the desired end result from the initial actions, the greater the amount of time required.[2]

Time

Objective Influence	Third-Order Effects	Second-Order Effects	First-Order Effects
War-making and sustainment capacity at front reduced	Movement of military logistics delayed to front	Road traffic halted accessing bridge; traffic flow diverted	Road bridge destroyed
Air superiority efforts advanced	Air-defense sector operations disrupted Air-defense network stressed	EW/GCI site disabled; sector acquisition capability disrupted	Communications-relay van within EW/GCI site destroyed
Opponent's balance upset and C^3 capacity degraded	C^3 within region disrupted and disabled	Shutdown EP to specific geographic region	Electrical transformer station destroyed
Ultimate Outcomes	**Exosystemic Influences**	**Intrasystemic Influences**	**Target**

Legend:
C^3, command, control, and communications
EP, electrical power
EW, electronic warfare
GCI, ground control intercept

Figure 14. Effect-Order Examples

To the extent that systems at the tactical level of war can be thought of as simple and those at the strategic level as complex, tactical-level effects are likely to have shorter life spans than those at the strategic level in terms of both effect rates and duration.[3] Operational-level effects can be said to fall somewhere between the two other levels in terms of immediacy and duration (see table 9).

Table 9

Time-and-Effects Relationships

Level of War	Relative Complexity of Systems	Relative Rate of Effects	Relative Duration of Effects
Tactical	Simple	Immediate	Short
Operational	Median	Intermediate	Medium
Strategic	Complex	Slow	Long

Intended and Unintended Effects/Consequences

Out of any given planned intent, FA yields both intended and unintended effects. Its unintended effects can be positive, negative, or neutral to the achievement of the intended objectives, thus giving rise to two issues. The first is how to know whether a given FA set has yielded intended or unintended effects. The second is what to do about unintended effects. The first issue of measuring for effects (both intended and unintended) was addressed in chapter 4. The second issue concerning

unintended effects assumes that the intended effects are evident and contributing to influencing the objective as planned. Given this assumption, the question really becomes, how do the unintended effects affect the intended ones? Table 10 outlines the three cases possible with unintended effects and a course of action is suggested for each case.

Table 10

Conditions of Unintended Effects and Future Actions

	Positive	Neutral	Negative
Unintended Effects	Contributing towards objective	—	Counterproductive to attainment of objective
Course of Action	Reinforce efforts	Persist	Desist efforts; change

The three cases and an FA planner's decision in each case are fairly evident from table 10. A fourth case not presented is really the most problematic—that is, a case in which both the intended and unintended effects are neutral. An implicit question with a neutral case is whether some threshold exists within the targeted system that, given additional effort, will yield results. On the other hand, if the effects being generated really are unable to influence the objective, then no amount of additional effects is going to yield effective results. This is where organizations such as JWAC and other system and behavioral experts can be particularly helpful in reassessing the linkages within the targeted systems.[4]

Organizing Schemes for Classifying Effects

Any organizing scheme for classifying effects will necessarily be incomplete, with important criteria left out. Nonetheless, it is necessary to limit the classifications to a manageable level in order to develop an effects-based approach to FA. As an FA planner approaches the task of organizing the effects desired to fulfill the objectives, he or she will find it useful to think of objectives as master effects.[5] Objectives are the end results of a planned stream of actions and effects. Using this concept, one can think of the planned effects as intermediate objectives. This study concentrates on second-order effects, which act through a mechanism to translate intermediate results into influence.

Interrelated Schemes for Classifying Effects

Having established the effects (from objectives), FA planners attempt to determine what targets will cause them. They are really using an "if then" proposition in reverse. The "ifs" are the initial causes, the targets that will generate the desired effects. However, as has been seen previously, being able to predetermine a given cause-and-effect chain can be a complicated business, rife with unpredictability and error. Nevertheless, FA planners

must select effects and invoke an appropriate mechanism to reason their choices. FA planners do not start from scratch. There are existing criteria to help organize effects, in an effort to develop coherent cause-and-effect rationales. Some of the possible organizing schemes for effects are discussed below; they are grouped to a master scheme organized along the levels of war in the subsequent section.

War Making, Sustainment, and Will. A key concept in an effects-based approach is that objectives and, therefore, effects can be organized according to three major functional areas of warfare: war-making capability, war-sustaining capacity, and war will of the enemy.[6] War making describes those forces and capabilities of an opponent that actually apply combat power—both men and equipment. War sustainment represents those forces and functions that enable the enemy to sustain the war. Production, supply, and distribution of war materials are principal elements of an enemy's capacity to continue war. War will is of course a mostly intangible element of the opponent that animates the enemy's overall commitment and resolve to continue to resist and attempt to achieve his own objectives. Most FA sets are planned to act on one or more of these three major functional areas of the opponent.

Forces and Functions. FA efforts and effects can be classified according to whether they will affect an enemy's forces or functions. The function's category is very broad, encompassing any system and its function that the enemy relies on for prosecution of his war effort.[7] Forces as a category is self-explanatory and is directly related to an opponent's war-making capability.[8]

Physical, Systemic, and Psychological. One can also classify effects according to whether they are primarily intended to have a physical, systemic, or psychological component. It is important to acknowledge beforehand that most FA effects will contain elements of all three categories. Nonetheless, it is also fair to say, at the same time, that a given FA set is planned to have a predominant effect on one of these effect groups.

The main purpose of a physical effect in FA is destruction (the physical elimination of the object). Effects associated with war making and forces are often planned to have a predominantly physical effect. Systemic effects are those planned functionally to disrupt a specific system or systems. These systemic effects are frequently referred to as functional effects. Psychological effects are planned to primarily affect the will of the adversary. Since the will of an opponent does not have a material basis, affecting will requires an indirect approach using second-order and higher effects.

Intrasystemic and Exosystemic. Effects that are planned to have a systemic impact are usually planned in anticipation of affecting one or more systems. Those effects planned to affect a singular system are intrasystemic, and those planned to affect multiple systems are exosystemic.[9]

Military, Political, Economic, and Social. These areas of a state are the classic categories to aid thinking about the context of any given international crisis. They not only describe an organizing scheme for generally

classifying effects but also are useful for classifying major instruments of power that one state can bring to bear upon another. Most effects will have some impact, however slight, on some or all of these four areas.[10]

Material and Nonmaterial. Almost all effects planned to be produced from FA start off as material effects. Material first-order effects can generate nonmaterial second-order effects. However, it is unreasonable to classify any given effect as wholly material or nonmaterial. Effects are better thought of as falling along a continuum containing material and nonmaterial elements, with physical effects being predominantly at the material end of the spectrum and psychological effects at the nonmaterial end; systemic effects fall roughly in between (see table 11).

Table 11

Effects Organizing Schemes

Tactical Level of War	Operational Level of War	Strategic Level of War
War Making	War Sustainment	War Will
Forces		Functions
Physical	Systemic	Psychological
Intrasystemic		Exosystemic
Military / Economic		Political / Social
Material		Nonmaterial

Summary

The effect-planning schemes for organizing and classifying FA efforts are summarized in table 11; the levels of war have been added, anticipating the discussion in the next section.[11] The schemes are meant as general guides to stimulate planning and not as listings from which to develop an effects-planning checklist.[12]

Effects Related to the Levels of War

Planning for effects to achieve objectives is the basis of an effects-based approach to FA. A logical extension is to associate a corresponding level of war with each objective. Tactical objectives are derived to fulfill operational objectives, and operational objectives, in turn, contribute to strategic objectives.[13] The objectives throughout the hierarchy can be associated with their respective levels of war and, in turn, effects can be classed to the objectives. This section argues that the levels of war can serve as a master scheme for organizing effects in FA planning.

The caveat, discussed in chapter 2, on planning FA that has been organized along the levels of war still applies. That caveat, restated, is an acknowledgment that there is a tension between planning effects with the intent to affect a single level of war and the tendency of effects to spread

across multiple levels of war. This dilemma recognizes the levels of war as distinct with clearly defined boundaries and at the same time as inseparable and fluid. Two excerpts from Air Force Manual 1-1, *Basic Aerospace Doctrine of the United States Air Force,* illustrate this dual nature. The first indicates that the levels of war are distinct: "Of particular importance is the principle of the objective and the required linkage between strategic objectives, operational (campaign) objectives, and tactical objectives. The objective is the driving force behind decisions at each level of warfare."[14] The second describes the levels as inseparable: "War is planned and executed at three levels: strategic, operational, and tactical. These levels are dynamically interrelated. There are no clearly defined boundaries between them."[15]

There has been a tendency in the past (particularly within the Air Force) to associate levels of war with particular weapon systems or targets.[16] This characterization has some justification; for example, generally strategic platforms (large bombers) do predominantly carry out strategic attacks. Additionally, over time there has developed a general scheme to organize targets according to the level of war most often associated with them. However, this scheme tends to assign value to the target before its value is determined by results. An emergent scheme classifies FA on the basis of the effects sought.[17] While this scheme is guilty of the same assumption of assigning prior value, it is necessary for planning purposes to assume that the effects will be achieved; otherwise no planning could take place. For purposes of this study, the proximate planned effects are the criteria considered when assigning a level of war and influence.[18]

Properties of Effects Related to the Levels of War

The following characterizations of effects related to the levels of war are based on the discussion in chapter 2. See also appendix C, which depicts these levels in a matrix.

Strategic Effects

Strategic effects (SE) are intended to affect the war as a whole. They are planned to influence the major functional areas of war sustainment and war will. SEs focus on COGs associated with *functions* such as infrastructure; logistics; command, control, communications, computers, and intelligence; leadership; and will. They should contribute to reducing and unbalancing the enemy's overall political, military, and economic capacities as well as his collective psychological stability (hostile will). In general, SEs generate slowly and require a long period to mature fully; their influence generally endures for a long time. SEs are most often associated with the deep or far battle. The traditional airpower mission related to SEs is strategic attack. Interdiction efforts generally achieve SEs by interrupting war materiel at its sources (production).

Operational Effects

Operational effects (OE) are intended to affect campaigns and/or major operations. They are planned to influence the major functional areas of war sustainment and war making. OEs focus on COGs associated with an enemy's forces. They should contribute to reducing and unbalancing the enemy's capacity to conduct successful campaigns and war (hostile ability). Most often, OEs generate at a medium rate and require an intermediate period to mature; their influence usually endures for an intermediate period. OEs are generally associated with the intermediate or next battle. The airpower mission most often associated with OEs is air interdiction, which at this level usually focuses on interrupting material in transit (distribution).

Tactical Effects

Tactical effects (TE) are intended to affect individual battles and engagements. They are planned to influence the war-making functional area. TEs focus on affecting forces and may not directly relate to a specific COG. They contribute to reducing and unbalancing the enemy's capacity to conduct battles on a relatively localized basis. In general, TEs generate and mature immediately, and their influence is equally brief.[19] TEs are associated with the close battle or engagement. Close air support is most generally associated with TEs. Interdiction efforts achieve TEs by destroying war material in use (operations).

Relating planned effects to a level of war is a helpful guide for balancing and weighing FA efforts. Additionally, the properties associated with effects at each level of war also serve as rough rules of thumb to forecast time, abstraction, and complexity relationships (see fig. 15).

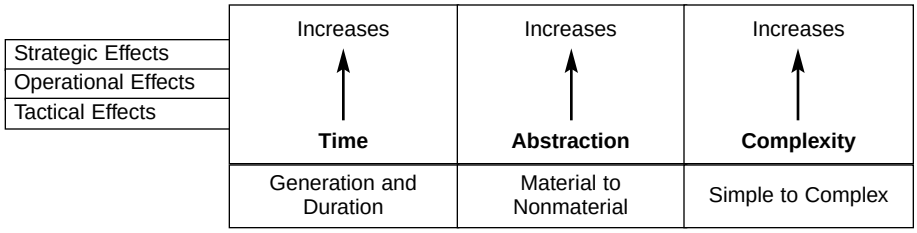


Figure 15. Effects: Rules of Thumb

Generally, as the level of war increases, the time required for the effects to develop, mature, and endure increases in proportion. Moreover, as one plans effects from the tactical to the strategic level, the relative degree of abstraction increases. This abstraction describes a general tendency for planned effects to move on a continuum from a material to a nonmaterial basis between the tactical and strategic levels.[20] Finally, tactical effects generally deal with simple systems, and their relative complexity is low. However, as one plans effects to higher levels of war, the relative com-

plexity increases due to an increase in the number and sophistication of systems (and their channels of interaction) at the higher levels of war.

Summary

In order to plan for effects, one must bound, class, and simplify them; otherwise the possibilities and sheer complexity will paralyze planners. This chapter has bounded effects by classifying them in several organizing schemes as well as one master codification organized along the levels of war. The general properties and classes for effects in this chapter provide a manageable framework from which FA planners can select effects to influence objectives.

FA planners—given sufficient information about an objective, the nature of a linked system to be affected, its context, and the initial weapon effects—can forecast and plan for distinct follow-on effects. To become dynamic, an effects-based approach requires timely feedback in the form of effects assessments that allow FA planners to regulate future actions based on exploiting those FA sets that prove most effective and influential.

An effects-based approach does not supplant a targets-based approach; it supplements it by shifting the focus to planning for effects first, before the targets. FA planners using an effects-based approach really use cause and effect in reverse. They begin with their desired effects and attempt to plan for causes to actualize them. Instead of an if-then proposition, FA planners using an effects-based approach formulate actions using a then-if hypothesis. Targets as the initial triggers in the cause-and-effect chain cannot be ignored any more now than in the past. FA planning must consider how to trigger the initial effects. Although the question of "how" is important, planners are also concerned with "what," as in "what targets will create the desired effects?"

Notes

1. *Gulf War Air Power Survey*, vol. 2, *Operations and Effects and Effectiveness* (Washington, D.C.: Government Printing Office, 1993), 27.

2. Ibid., 72. Moreover, accompanying this proposition (discussed in chap. 4) is an attendant proposition that the longer the cause-and-effect chain, the greater the potential for uncertainty and an attendant decrease in predictability. As a caveat to this proposition, one should note that it is not a law. For example, it did not take very long from the dropping of the atomic bombs and the Soviet invasion of Manchuria to induce the Japanese to surrender.

3. This assumption is implicit in chap. 4 but admittedly unstated. The rationale for this assumption is a general association that tactical systems tend to have few relationships and to be relatively isolated. On the other hand, strategic systems tend to have many relationships and to be highly interconnected. As with any general assumption, they are made at the expense of exceptions. However, this assumption is useful for purposes of simplification and aiding additional codification of effects. See also Air Force Manual (AFMAN) 1-1,

Basic Aerospace Doctrine of the United States Air Force, vol. 1, March 1992, 11–13. See also Joint Publication (JP) 3-03, *Doctrine for Joint Interdiction Operations,* 10 April 1997, vi.

4. JWAC would be of great use in any assessment of systems along their seven competencies. However, the more the systems being acted on move into social and political contexts, the more other expertise should become involved in evaluating the nature of the effects and influence. This assessment can also be thought of as a general reassessment of the determinism possible between the system and FA.

5. JP 0-2, *Unified Action Armed Forces,* 24 February 1995, viii.

6. Phillip S. Meilinger, "Towards a New Airpower Lexicon—or—Interdiction: An Idea Whose Time Has Finally Gone?" *Airpower Journal,* summer 1993, 43–44. Meilinger sees these three areas as being like three pillars upholding a state's ability and commitment to continue a war. Therefore, they are a logical choice upon which to focus FA efforts to influence an adversary's hostile ability and will. See also David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995), 2.

7. JP 3-0, *Doctrine for Joint Operations*, 1 February 1995, III-17. Joint doctrine takes a narrower interpretation of functions and classifies them according to their ability to bear on the forces of the enemy. This study's interpretation is broader, encompassing all the functions within in a state—not just those that directly bear on a state's forces.

8. JP 3-03, v.

9. This interpretation can be problematic, depending on what one defines as constituting a system. For purposes of this study, systems will generally refer to the seven competencies advanced by JWAC plus command, control, communications, computers, and intelligence (C^4I), as well as leadership. This list of nine systems would include electrical power; petroleum, oil, and lubricants; lines of communication; telecommunications; critical industries; commodities; military logistics; C^4I; and leadership. However, just thinking in terms of these systems is limiting. There is a need to expand thinking and classification on systems and add more competencies.

10. The JWAC routinely assesses any planned actions and effects in light of how they will bear on these four areas: military, political, economic, or social.

11. Additionally, a matrix that combines previously discussed relationships and classes of phenomena is provided for thought in appendix G. The matrix should be viewed judiciously. It is tempting to draw conclusions by inferring relationships from reading the columns vertically. But this viewpoint hazards ignoring the potential for FA effects to generate in unique and unpredictable fashions. Nonetheless, some broad relationships are an intriguing potential—implicit in the matrix.

12. As an additional caution, the table summarizing the effects should not be taken as describing any absolute relationships by reading down a particular column. The figure really describes various classes of effects that must be considered individually from within a class. Relating the classes is a goal of effects planning, but the table did not attempt in a deliberate fashion to align the classes vertically to form interclass relationships. Speculations on effects and interclass relationships are beyond the scope of this study.

13. This does not, however, imply a need to work bottom-up from the tactical to the operational to the strategic. Other alternatives include working all levels simultaneously and/or working top-down from the strategic to the operational to the tactical.

14. AFMAN 1-1, 9.

15. Ibid., 2.

16. Mark J. Conversino, "The Changed Nature of Strategic Air Attack" (paper presented at the National Defense into the Twenty-first Century Symposium, 24–25 February 1997), 13.

17. Air Force Doctrine Document 2-1.2, "Strategic Attack, United States Air Force," draft, December 1997, 24. See also Conversino, 8–9 and 13.

18. A question arises of how far to project the effects of any given FA to derive and specify its intended level of war. It can be argued that all FAs eventually contribute to strategic objectives—in essence that all effects eventually have a strategic influence. However, this

argument “fails to meet the test of proximate versus distant causation.” John Lewis Gaddis, *We Now Know* (Oxford, U.K.: Clarendon Press, 1997), 35.

19. However, cumulative TEs may amount to OEs or even SEs; for example, losing enough fighters produces a strategic, not just tactical, effect.

20. Note an additional observation associated with this material: nonmaterial continuum is a change in effects-assessment methods. The assessment methodologies tend to shift between quantification and qualification as the material basis of the effects decreases and the planned level of war increases.

Chapter 6

Target-Effect Pairings and Mechanisms

> *In dealing with the various formulations and representations of the intangibles [and tangibles] of war and war planning we should expect to find many differences of opinion and procedure. These should not disturb us—for differences are not necessarily contradictions. Frequently the differences are more apparent than real and usually they merely represent two [or many] different but equally good approaches to a problem.*
>
> —Henry E. Eccles
> *Logistics in the National Defense*

Planning the right effects to achieve the desired objectives is vital to effective FA; equally vital is planning the right targets to achieve the effects. FA planners must consider what pairings between targets and effects make the most sense. Fortunately, many past and present FA theorists have developed target-effect pairings and associated mechanisms that can be studied for applicability today. This chapter addresses the works of J. C. Slessor, Henry E. Eccles, Thomas C. Schelling, and David A. Deptula.

Effects Thinking—Past and Present

The schemes for classifying effects offered in chapter 5 are used as evaluative criteria to assess the various ideas about effects. The evaluation will pay particular attention to explicit and implicit target-effect pairings and mechanisms expressed in the various works.

J. C. Slessor

Slessor's *Air Power and Armies* is unique among works by airpower theorists of his day for upholding and detailing airpower's role in contributing to the defeat of an enemy's army.[1] Contemporary airpower has been criticized for not devoting as much attention to how to affect armies as it has to affecting other systems.[2] This may be a fair criticism; however, Slessor fills this very need by treating an enemy's land forces as a system and analyzing how airpower can best reduce their capacity for resistance.[3]

Slessor thought of the enemy as a system; therefore, he looked for systemic means to influence it. He favored functional effects rather than physical effects. Both tendencies are reflected in this telling passage: "Strictly speaking a vital centre is an organ in a man, an army, or a nation, the destruction or even interruption of which will be fatal to continued vitality. Note that actual *material destruction* of a vital centre is *not* essential in order to be fatal" (emphasis added).[4] Slessor identified two

subsystems as being vital to the functioning of an enemy land force—communication and supply.

Slessor developed a systematic approach to influencing an enemy land force based on two principal means; the first focused on enemy troops, the second on supply.[5] He outlines both alternatives in some detail but took care to point out that the alternative strategies were not mutually exclusive. Importantly, Slessor developed several specific target-effect pairings (see table 12).

Table 12

Slessor: Target-Effect Pairings

Effects (Outcomes)	**Targets** (Causes)
Fighting-Troops Alternative	
Kill them (elimination)	Soldiers
Prevent them from being in the right place at the right time	Rail—communications Roads—needed for strategic and tactical mobility Headquarters—control and direct
Supply Alternative (Production and Supply in the Field)	
Ruin their fighting efficiency Deprive them of supplies of food and war materiel	Food supply Munitions Supply depots at bases and lines of communication

Within the supply alternative, Slessor detailed two subareas for FA: an enemy's production of war materiel and his supply of war materiel in the field. These two subareas (along with the other items listed in table 12) describe an overall system of interdiction that airpower can employ against an enemy land force. Interdiction—as Slessor developed it—can occur along a continuum of supply from its productive sources to its depots to its distribution along LOCs, and finally to its use by actual fighting units.[6]

Slessor speculated about "where" FA efforts were best used against an enemy land force. He concluded that generally supply and transportation are the best FA targets.[7] Slessor also detailed what was essentially a classic principle of interdiction, holding that the most effective means of interdicting an enemy land force is to use land power and airpower in tandem. In this scheme, land power stresses the enemy force, driving up its needs for communications, reinforcements, and supply, while airpower simultaneously isolates the enemy land force by starving it of sustainment and control.[8]

Slessor took a balanced approach to FA and recognized all the levels of war.[9] However, he suggested that airpower was best used at the operational and strategic levels.[10] Slessor had specific ideas on what target-effect pairings were most influential in affecting an enemy land campaign, identifying communications, supply, and transportation. Slessor's implicit

mechanism was that enemy land forces would be influenced by attacking their dependencies. He reasoned that armies depend on supply and transportation; interrupting these functions will reduce their capacity for resistance.

Henry E. Eccles

Eccles, who wrote *Logistics in the National Defense* from the standpoint of a logistics planner, concentrated primarily on the command aspects of logistics in war, but his work took a broad view towards strategy.[11] He proposed thinking about affecting the enemy in terms of control and influence, not strictly destruction.[12] His approach to warfare was to think through beforehand how planned actions would influence the enemy, essentially what effects would be generated: "Not only must one think of how the enemy views the situation as it exists before one takes action, but one must think of how the enemy thinking will be influenced by the action one takes."[13] The negative aspects of control that Eccles developed were to *deny* control functions or interdict control elements of the enemy's logistics.[14] Like Slessor before him and Deptula after, he did not see the need solely for destruction if control over the system or function desired can be gained by denial or interdiction.

The means of control that Eccles developed focused upon an enemy's logistics, which he described as the link between a nation's economy and its combat forces: "Both the enemy's armed forces and his economy become targets for destruction or control. His logistic system, being the bridge between his economy and his tactical ops, becomes a particularly important target."[15] Eccles defined logistics as "the creation and sustained support of combat forces and weapons," and civil logistics as "the mobilization of the civilian industrial economy to support the armed forces."[16] Essentially, Eccles suggested that the best means to influence an adversary was to act at the operational level to control his logistics and, thereby, influence his ability to sustain the war (see fig. 16).

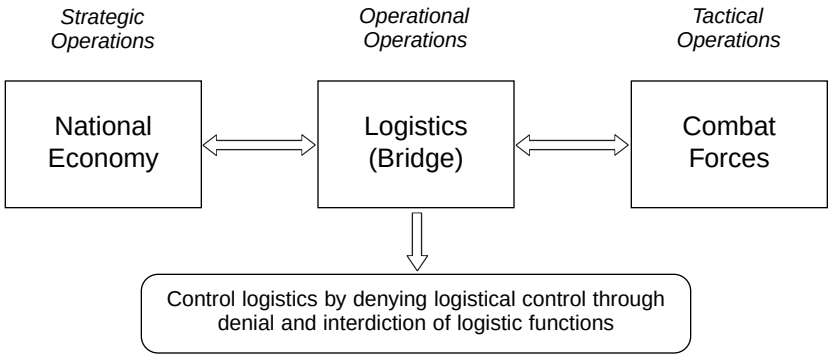


Figure 16. Eccles: Logistics Control

Eccles indirectly described FA at the operational level of war.[17] This implication resulted from the function where he describes a bridge linking strategic operations with tactical operations. Eccles's strategy of logistical interdiction is best characterized as acting on the major functional area of war sustainment. His approach is directed against functions (logistics) rather than forces. He advocated a systemic approach against the enemy's logistical-control system. Unfortunately, Eccles did not detail specific targets; therefore, his targets can only be deduced as C^3 and supply (distribution). Eccles's implied mechanism was that denying and interdicting an enemy's logistical ability to sustain war would critically reduce his ability to control his economy and combat forces.

Thomas C. Schelling

Schelling wrote *Arms and Influence* primarily about nuclear deterrence, but the work has much to say about the larger relationships between diplomacy and force. Indeed, the greater portion of *Arms and Influence* is spent on developing a theory of coercion in conventional warfare. Schelling sees the military use of force in terms of its psychological influence and its potential to modify behavior by threat and actual use of force.

Schelling argues that military forces are primarily used to hurt and to destroy value. He further asserts that the primary effects of military force are shock, loss, grief, privation, and terror.[18] For Schelling, what matters in FA "is not the pain and damage itself but its influence on somebody's behavior."[19] The object of Schelling's behavioral modification—the target of influence—is the people and government of the enemy.

A primary construct in Schelling's strategy of influence is a differentiation between coercion and brute force. But the primary difference between the two is that of intent (see table 13). An FA strategy based on coercion intends to modify the enemy's behavior through judicious and selective force. The idea behind this strategy of coercion is to induce the enemy to cooperate by selectively hurting him and damaging what he values.[20] The alternative Schelling offers to his strategy of coercion is one of brute force.

Table 13

Schelling: Coercion versus Brute Force

Coercion	**Brute Force**
Intent to modify behavior through judicious and selective FA	Intent to exterminate behavior through outright elimination
Compellence	***Forcible Offense***
– Inducing enemy's withdrawal or his acquiescence – Eliciting enemy collaboration by threat of future punishment	– Taking something or occupying a place – Disarming an enemy and/or territory
Techniques of Influence	***Techniques of Destruction***
Bargaining and Intimidation	Conquest and Defense

The intent of a strategy of brute force is to eliminate behavior through outright destruction. Schelling associates the brute-force alternative with displacing or disarming an enemy.[21] His ideas on compellence and influence as opposed to brute force and destruction are illustrated in this passage: "[The technological enhancement in military power to hurt] in turn enhances the importance of war and threats of war as techniques of influence, not of destruction; of coercion and deterrence, not of conquest and defense; of bargaining and intimidation."[22]

Many of Schelling's assumptions in table 13 merit discussion. One of the most limiting aspects of his coercive influence is its primary focus on the enemy's population, which assumes that since people are the prime movers of change within the enemy state, they are the best targets.[23] Schelling later revises this argument somewhat with an admission that governments themselves may be unsusceptible to coercion.[24] This lack of coercive vulnerability has two aspects: the people may not have a relationship with the government, and governments do not make decisions the same way individuals do.[25]

To his credit, Schelling holds out the possibility that coercive warfare may be directed at things the adversary values other than his population.[26] This potential for coercion, by attacking targets other than an enemy's population, supports the idea of selective and coercive FA. Selective FA can be used to influence an adversary through functional disablement and reduction of his war-making capacity. This is what Schelling intimates when he discusses targeting for influence versus targeting for destruction.[27]

In Schelling's strategy, coercion is best applied at the strategic level of war, aimed at the will of the people (and government). His intended FA effects are predominantly psychological and almost exclusively aimed at the political and social aspects of the state. His target-effect pairings, like Eccles's, are somewhat nonspecific. He details the effects of shock, loss, grief, privation, and horror but only loosely couples these to blockade and bombardment as strategies to develop targets. Schelling's implied overall mechanism is that an enemy state can be compelled to modify its behavior by judicious and selective use of force. This inflicts pain and damages value to such an extent that it motivates the enemy to avoid future hurt and loss by acquiescing to the coercer's demands.

David A. Deptula

Deptula is perhaps best known for his role as the principal offensive air-campaign planner for the joint force air and space component commander (JFACC) during Operation Desert Storm. Additionally, as a member of Checkmate and as Warden's protégé, he had considerable influence on the original Instant Thunder plan.[28] The influence of Warden and his systems approach is evident in Deptula's strategy of parallel warfare. Deptula's contribution to effects thinking is found in *Firing for Effect: Change in the Nature of Warfare,* published in 1995. Because his approach assumes the

viewpoint of an airpower planner and strategist, he thus seeks a new effects-based methodology for FA.

Deptula also advocates a systems-type approach to FA that continues in the tradition of the ACTS and Warden. This systems approach essentially holds that the enemy relies on vital systems that, in turn, control vital functions. By attacking and disabling these systems, one can achieve control over the enemy.[29] Deptula's list of vital systems is an exact echo of Warden's five-rings construct. Like Slessor, Deptula emphasizes that system analysis is necessary to achieve effective FA against the correct critical component of a given system.[30]

Deptula proposes an ideal employment of economy of force. This employment, Deptula maintains, in which all efforts are linked to objectives, is facilitated by an effects-based approach to FA.[31] He further describes this planning for effects as being organized according to the levels of war: "The crucial principles defining parallel warfare are how time and space are exploited in terms of what effects are desired and for what purpose at each level of war."[32]

Because of Deptula's systems orientation, his primary effects are systemic rather than physical or psychological.[33] He concentrates on affecting the parent system and therefore can be said to have an intrasystemic focus on effects.[34]

Throughout, Deptula emphasizes targeting for effect versus targeting for destruction.[35] He maintains that destruction is not an end in itself but a tool to achieve the desired effects—to functionally disable vital systems the enemy relies on for control.[36] He also outlines a nominal planning process for an effects-based approach (see fig. 17).

A key concept in Deptula's strategy for parallel warfare is the concept of control, achieved by affecting the essential systems of the adversary—those that the adversary relies on for control of his forces and functions within the state or organization.[37] Deptula argues that it takes less effort to control a system through selective force (targeted at an essential system component) than it does to destroy the whole system.[38] This concept

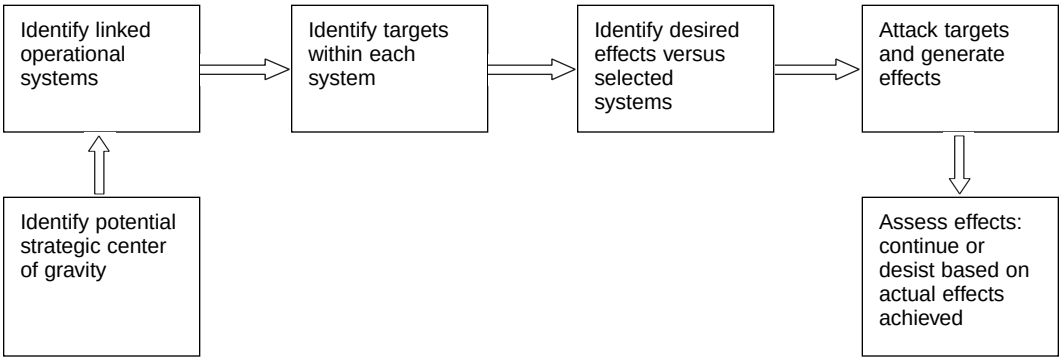


Figure 17. Deptula: Effects-Based Planning

is essentially a credo of leverage, which is well established within a traditional systems approach and a maxim of nonlinearity.[39]

Deptula argues that the operational level of war is a means to affect the strategic level and to deny the adversary effective use of his strategic activities of control.[40] The effects that he emphasizes are those that deny an opponent control of essential systems. The intent of these systemic effects is the functional disablement of vital enemy systems that the enemy relies on for control. The specific targets that Deptula ties to these systemic effects are leadership, essential industries, transportation and distribution, communications connectivity, and military forces.

Deptula's explicit mechanism is that functionally disabling the adversary's essential systems of control at the operational level will, in turn, paralyze his ability to function at the strategic level. At that point, the enemy will have no choice other than acquiesce to the will of the controlling forces or face ever-increasing losses and lack of control.[41]

Synthesis of Effects Thinking

All the theorists discussed in this chapter point in the direction of FA as a means to generate influence. Importantly, they all see destruction as a means and not an end in FA. Destruction provides the means to generate effects, which can be targeted against specific components of a system. With the exception of Schelling, the theorists all tend to adopt a systems view towards the areas they seek to influence. The theorists are all trying to economize FA efforts by looking for leverage within their respective systems. The concept of leverage, implicit in all their work, is that a vital component or system can be affected with a small, selective application of force and yet yield systemwide effects. This selective FA, in turn, leads to greater economies in future FA efforts.

Again, with the exception of Schelling, the three tend to target both forces and functions within the adversary state. Slessor's work was specifically aimed at how to address an enemy land force as a system, but he still ties in the critical functions of supply and transportation. Eccles includes both the economy (as a macro function) and combat forces in his FA strategy and plans to affect both through a common logistical system. Deptula, like Warden, focuses on the C^2 function within a state (or organization) but also includes forces as a major area.

The various mechanisms of the theorists are summarized in table 14. What stands out, again with the exception of Schelling, is that they are all thinking in terms of functional effects and are looking for ways to functionally disable essential systems instead of ways to destroy those same systems. It is, in essence, the difference at a systems level between virtual attrition and annihilation. The implication of this approach is a potential for greater leverage and economy of force as well as less cost in terms of blood and treasure to both sides.

Table 14

Mechanisms Summary

FA Source	Mechanism Statement	Areas Targeted
Slessor	Enemy land forces are best influenced by attacking their functional dependencies of supply and transportation.	Army
Eccles	Affect an economy and combat forces by denying an enemy his logistics-control function.	Economy and Combat Forces
Schelling	Modify a state's behavior by inflicting pain and damaging what the state values.	Government and People
Deptula	To compel an adversary to acquiesce functionally, disable his essential systems of control.	Leadership (operational and strategic levels), essential systems, infrastructure, and forces

Schelling's contribution is unique—an emphasis on FA as a means of persuasion. Clausewitz first advanced this idea of the military as a persuasive force when he wrote that the military is a political instrument and that "war is simply the continuation of policy by other means."[42] There is a tendency in warfare to lose sight of the fact that FA is, ultimately, trying to compel the enemy to modify his behavior. Very often in warfare, the fighting and destruction become ends in themselves instead of means subordinated to persuading the adversary. Clausewitz and Schelling are right; we are, ultimately, trying to compel an adversary by the use of force to modify his behavior.

Summary

There is a sound theoretical basis for a systems-and-effects-based approach to FA that stresses coercive functional effects rather than brute destructive effects. This approach emphasizes physical, systemic, and psychological effects as a primary means of influencing an opponent primarily at the operational and strategic levels of war. Selective FA can induce effects that generate disproportionate impact within selected systems in order to satisfy linked objectives. The systems that these theorists identify as possessing the greatest influence vary, but the central idea of seeking disproportionate effects (leverage) out of destruction does not.

Notes

1. J. C. Slessor, *Air Power and Armies* (London: Oxford University Press, 1936), 1.
2. On the one hand, JWAC does not carry an enemy's land forces as a competency that is systematically studied and detailed as a system. On the other hand, interdiction as a prime airpower mission is essentially the system solution that Slessor develops. So, in a sense interdiction is the mechanism whereby airpower intends to influence land forces.
3. Slessor, 16 and 82.
4. Ibid., 16.
5. Ibid., 63.

6. Ibid., 63 and 83. Eccles makes a similar argument but substitutes the overall term *logistics* for Slessor's *supply;* where Slessor seeks to interrupt supplies and reduce fighting capacity, Eccles seeks to deny logistics and control the opponent.

7. Slessor, 201. In Slessor's view the depth (level of war) at which interdiction was required also depended on the activity level of enemy forces, whether they were engaged, at rest, or building up to combat. He takes into account the delayed nature of effects and reasons that if a land force is engaged, it wants its desired effects immediately. Therefore, in the case of engaged forces, interdiction should occur at the tactical level and have an immediate impact. In another case, if land forces are at rest, interdiction should attack supplies or even production of supplies at higher levels of war, because the effects can afford to be delayed.

8. Ibid., 213.

9. The operational level of war was not yet recognized at the time of Slessor's *Air Power and Armies*. Slessor advocated interdiction to affect the enemy's strategic-tactical LOCs.

10. Slessor, 90–91. The author has interpreted Slessor as stating this implicitly. What he actually said was that a highly mobile weapon like the aeroplane should be used against profitable objectives, located farther back than an army's front.

11. Henry E. Eccles, *Logistics in the National Defense* (Harrisburg, Pa.: Stackpole Co., 1959), ix.

12. Ibid., 26–27.

13. Ibid., 25.

14. Ibid., 27. Eccles allows that destruction is a form of control.

15. Ibid., 30.

16. Ibid., 22 and 49.

17. As was the case when Slessor wrote, the operational level of war was yet to be named; nonetheless it is what Eccles described conceptually by function.

18. Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966), 2 and 18.

19. Ibid., 3.

20. Ibid., 2, 5, and 80.

21. Ibid., 2, 5, and 79.

22. Ibid., 33.

23. This same exclusive notion of the civilian population as the primary target of the military's power to hurt and damage value is observed in *Bombing to Win,* in which Robert Pape develops two strategies based on Schelling's work. The first he calls risk, which is essentially Schelling's gradual raising of hurting and future hurting as a compellent. The second strategy is punishment, and this too is very Schelling-like. Punishment is the ability to coerce an enemy by damaging what he values. Unfortunately, like Schelling, Pape also overdetermines the enemy's population as the only target of compellent value and influence within an enemy state. This is discussed in chap. 7 in detail.

24. Schelling, 80–86 and 180. Also at page 180 he describes the caveat that national leaders can be coerced only if they are responsive to their populations.

25. Both of these ideas have much discussion potential that, unfortunately due to time and scope constraints within this study, cannot be pursued. However, the first aspect has been taken so far as a suggestion that only democracies exhibit a true relationship between people and government and therefore would be susceptible to Schelling's population coercion. The second aspect of the governmental decision-making process has been classically outlined in the seminal work by Graham T. Allison, *Essence of Decision* (New York: HarperCollins, 1971), see matrix summary on page 256.

26. Schelling, 174.

27. Ibid., 33.

28. Checkmate is a division within the Air Force's Operations Directorate (XO). Its purpose is to lead strategic and operational contingency planning within the Air Staff. Additionally, it assists the numbered–Air Force planners and staffs, serving as a kind of

sanity check and as reach-back support. Instant Thunder was the name used to designate the opening days of the air campaign during the early planning in August 1990.

29. David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995), 3, 6, and 11–12. This notion of attacking vital systems is very reminiscent of Slessor's ideas on attacking vital centers in *Air Power and Armies*, 16.

30. Deptula, 11.

31. Ibid., 4–5, 8–9, 12–14, and 17–18.

32. Ibid., 4.

33. Ibid., 12.

34. Ibid., 16.

35. Ibid., 4, 8, 12, and 17.

36. Ibid., 10. Deptula criticizes current targeting approaches in a similar fashion to Rinaldi's discussion of an input-based approach to targeting, in which targets are struck individually and sequentially from a list. In this approach the number of sorties required for each target is based on the weapon effects to destroy the target, not the functional effect of the destruction upon the system the target is within. Both Rinaldi and Deptula term this approach a *servicing targets* mentality and an approach to be avoided.

37. Ibid., 5–6, 18. Deptula's idea of control sounds a lot like Eccles's concept of achieving control over the enemy's logistical systems. The difference is that Deptula advocates controlling the control systems of the adversary (leadership and other vital essential systems) while Eccles advocates controlling the enemy's logistics systems (particularly its C^2 element). The two theorists' ideas of control are very similar. As a critique of Deptula's idea of control, it is not clear how one technically has control of a system simply by denying its effective use by the adversary. It is true that by denying control of a system, the enemy cannot use it, but friendly forces cannot use it either. In my mind, control means that one has gained use of the system. He is really describing a control by negation, essentially denying the opponent the ability to control his own system.

38. Ibid., 6.

39. See appendix F, "Systems Approach." The so-called credo of leverage is a construct of this author; however, it is an implicit paradigm present in many theories of FA. It is primarily drawn from the work of the ACTS, especially the industrial web theory. The ACTS concept of identifying and selectively attacking a bottleneck in a critical industry of an economy is essentially using the leverage credo as its mechanism. The leverage credo states that all wholes are made of parts; some parts are more critical to the whole. Assessing and destroying a critical part affects the whole; affecting a part takes less effort than destroying the whole.

40. Deptula, 6 and 18.

41. Ibid.

42. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 87.

Chapter 7

Coercive Force Application and Effects

The power to hurt is nothing new in warfare, but for the United States modern technology has drastically enhanced the strategic importance of pure, unconstructive, unacquisitive pain and damage, whether used against us or in our own defense. This in turn enhances the importance of war and threats of war as techniques of influence, not of destruction; of coercion and deterrence, not of conquest and defense; of bargaining and intimidation.

—Thomas C. Schelling
Arms and Influence

There is a choice in prosecuting war between idealized coercive efforts and pragmatic brute force. This chapter explores this tension and develops a general theory of coercive force application. A systems-and-effects-based approach aids coercive FA by targeting for influence rather than targeting solely for destruction. Selective FA considered as a coercive force is portrayed as the fine art of modifying material in order to modify behavior.

This chapter also examines coercive effects by exploring some methods to render an opponent's will more tangible and, therefore, targetable. Three general areas of effort—physical, systemic, and psychological—are developed as a means to act on an opponent's will. A composite matrix of associations to coercive FA is integrated from previous propositions as well as associations derived from an analogy within this chapter. A discussion of the matrix addresses the tension in FA between idealized efforts and pragmatic ones.

Coercive Force Application

A general theory of coercive FA states that force can be selectively applied within an opponent state against various targets in order to modify the opponent state's behavior. A key concept of coercive FA is targeting for influence versus targeting solely for destruction.[1] The concept of targeting for effect places more emphasis on the after-action results of destruction—the influence rather than brute destruction as an end in itself.

Brute Force: An Alternative Theory

A helpful perspective from which to view the viability of coercive FA is to consider its polar alternative: brute-force FA, which concentrates on destruction for eliminative purposes.[2] The focus of this strategy is not to influence but defeat the enemy outright, employing a strategy of annihilation. Coercion's intent, on the other hand, seeks to persuade an opponent by applying force and offering alternative, negotiated solutions to the vio-

lence (bargaining). This difference highlights that coercion, best applied, always keeps the idea of influencing the opponent foremost over destroying the opponent. The value of coercion over brute force is that it holds the prospect of greater economy of effort in achieving one's will, because it takes less effort to destroy some things and get an opponent to capitulate than to destroy all things and annihilate an opponent.

A Basic Framework and Process Model for Coercive Force Application

The basic process for planning FA to influence an opponent begins with identifying objectives.[3] The ultimate objective is a better state of peace; subordinate objectives follow from this first objective.[4] Once objectives have been identified, the enemy is assessed in depth to determine what effects can be generated and coupled to a mechanism that will influence the opponent to move towards the desired behavior.[5] The last step in the process takes the desired effects and relates them to targets whose destruction or damage will produce the identified effects.

A Selected Historical Basis for Thought on Coercive Force Application

The FA theories of Carl von Clausewitz, Thomas C. Schelling, and Robert A. Pape are examined to outline the basis of a coercive framework for FA.[6] The examination concentrates on Pape's strategies of risk, punishment, denial, and decapitation.

Clausewitz. The great Prussian military theorist developed a formulation of an enemy's resistance as a product of his total means available multiplied by his will.[7] This essential formula of an enemy's resistance defines the basic choices for coercive FA: attack the hostile ability, the hostile will, or both.[8]

Schelling. Thomas Schelling develops FA into two basic schemes: brute force or coercion. He further divides coercion into branches of deterrence and compellence. Both branches of coercion use force; one is the threat of latent force (deterrence), and the other is potential or actual FA (compellence). Both coercive methods intend to modify behavior through the power to hurt (destruction), which is the active tool of coercive FA. According to Schelling, if the enemy behaves in accordance with our will, it is because we have hurt him in the past, we are hurting him in the present, or he believes we will hurt him in the future.

Pape. Robert Pape classifies coercive airpower applications into four strategies: denial, punishment, risk, and decapitation. The strategies are also applicable to future employment of airpower. Denial is essentially coercive force that acts on hostile ability; it can also be expressed as counterforce. He defines a strategy of denial as one that seeks to deny the opponent from obtaining his objectives.[9] Pape asserts that the principal means of a hostile state's obtaining its objectives is via its military forces.

Therefore, denial can principally be associated with FA's acting on a state's military forces.[10]

Pape, like Schelling, defines punishment too narrowly, limiting it to attacks on civilian populations. This narrow view is also attributable to an airpower legacy carried over from Douhet of bombing civilians to demoralize a government and break its will. A better concept of punishment would broaden its definition to anything valued within a hostile state. However, this can lead to confusion in the case of an opponent's military forces because they are at once the means for obtaining an opponent's objectives and therefore subject to a strategy of denial, but at the same time are valued by the opponent. This confusion can be remedied by excluding military forces from a punishment strategy, while still acknowledging their obvious value to an opponent. Hence, punishment then becomes a countervalue strategy, potentially encompassing everything else that can be identified as valued by the opponent.[11] Pape's third strategy, risk, is a derivation of punishment, based on Schelling's work on coercion.[12] This strategy holds that one can coerce an opponent most efficiently by gradually escalating the amount of punishment inflicted.

The last strategy is decapitation, which Pape adds in order to accommodate Warden's "Instant Thunder" strategy of attacking leadership and C^3.[13] Decapitation is a hybrid strategy that combines elements of both denial and punishment, in which both military and civilian leadership are attacked as well as C^3. This strategy holds that by eliminating key leadership and C^3, one renders the enemy powerless to achieve his objectives (denial) and causes him to suffer a decisive loss in value (punishment).[14]

Pape's strategies, with an expanded description of what is valued by an adversary, are an excellent basis for conceptualizing coercive FA. The theories are sound, though when Pape applies his theories to historical analyses, the conclusions he draws are open to interpretation and argument.[15] This study departs from Pape's framework with regard to his general tendency to consider the strategies as mutually exclusive. This study holds that coercive FA is more effective when FA planners have the flexibility to integrate the strategies according to the dictates of the situation.

Challenges to Coercive Force Application

A central proposition underlying this section is that existing coercive FA theory is sound; the challenge lies in its planning and execution. The critical task to planning and implementing coercive FA is assessing an opponent's behavior and then linking it to a material means (force application) to modify that behavior. A system-and-effects-based approach to FA, with its focus on targeting for influence and thinking in terms of a mechanism, aids this critical task of coercive FA.

Understanding the Opponent

An opponent should not be understood through any one assessment, but through a series of alternative assessments and reassessments. These assessments would contribute to an attitude of uncertainty concerning an opponent and help guard against an attitude of certainty that tends to take hold in FA planning.[16]

Mind-Set Analysis. The assessment of an enemy's mind-set can only be inferred and deduced because it is largely a collection of beliefs. But from the core set of assumptions concerning an enemy's mind-set and strategy, FA planners build a model of what they think will influence the enemy.

It is important to FA planning that basic questions concerning the enemy's mind-set be appraised. Examples of questions that help evaluate the enemy's mind-set include the following: How does the enemy view his situation? What are his stakes, interests, and motivations? How is he governed, and how does he make decisions?[17] Well-founded FA strategy must begin with as complete an understanding of the opponent's mind-set as possible. The aim is to discover the fundamental basis of the opponent's behavior.

Biases. Two of the biases responsible for inaccurately assessing the enemy are mirror imaging and attribution. Mirror imaging is the tendency to think about and form beliefs about an enemy in one's own image. In general, people tend to project their motivations and their cost-benefit calculus unto others. These presumptions may or may not have much to do with the actual mind-set of one's opponent.[18]

Attribution bias holds that when assessing one's own behavior, one often views it as a composite of many influences and constraints; but when assessing another's behavior, one views it as deliberate and purposeful.[19] This tendency tends to obscure the complexity of another state's decision-making process and the influences on that process. Hence, the enemy's mind-set is not completely understood.

Expectations and Feedback

Whenever FA strategists venture from brute-force destruction into coercive FA, they encounter increased difficulties in application. Predicting effects intended to have an influence beyond destruction is difficult, as is measuring those effects after the destructive action.[20] The assumption in targeting for effect is that the initial destruction, a first-order effect, is transformed over time into various second-order effects, which in turn influence behavior.[21] Given this assumption, coercive FA is better approached as an experiment rather than as a procedure.

Currently, FA strategists start with a hypothesis (mechanism) about how a given action or series of actions (target-effect pairings) will effectively influence the opponent. However, efforts to measure the effects and effectiveness of the actions and check the FA hypothesis for validity run into problems with measuring second-order effects. Given this predicament of imperfect FA assessments, FA planners should strive to obtain

what feedback is available and be skeptical about their FA hypothesis until they get clear confirmation of its effectiveness.

The options for FA planners faced with little or no feedback are to continue more of the same or try something different, and this is important—both options are equally unproven. There is a critical need for feedback; there is not enough assessment for FA planners to check assumptions in order to see if their actions are having the intended effects. To become an effective instrument of influence, coercive FA requires feedback in order to regulate future FA.[22] As an example, had the Germans during the Battle of Britain received feedback on the true effects of their initial bombing efforts, they undoubtedly would have persisted with most of them. Examples of target sets that had merit but were prematurely abandoned by German FA planners included the Spitfire factories, sector stations, and airfields.[23]

Analyses and assessments of the enemy are best framed as beliefs, not facts. The enemy seen in this uncertain fashion represents a set of possible behaviors, and one's plans to influence his behavior are more properly assessed in terms of probabilities rather than certainties.[24] A strategy of coercive FA, when confronted by competing beliefs and probabilities regarding an enemy, should do what all wise strategies have done before—hedge. This composite strategy should in general employ both a pragmatic strategy that focuses on attrition and a more idealistic strategy that concentrates on virtual attrition.[25] Irrespective of the strategies employed, FA planners need to continually assess the opponent and refine assumptions concerning his behavior. This continual assessment should provide more effective future applications to influence the opponent's behavior.

Coercion to Brute Force

Choices for FA can be selected along a continuum between coercion and brute force. These same choices can be represented as seeking an ideal solution or a more pragmatic one to warfare. A continuing challenge for coercion in warfare has been how to get the most influence from the least possible force. Classic formulations for defeating an opponent usually describe the need to reduce the opponent's total means and will to resist. Reducing means has been a straightforward, pragmatic task, while reducing will has been more idealized and problematic. The problem with attacking will has been that it is intangible. However, because it continues to be a pervasive and powerful force in warfare, it will always remain a potentially lucrative target for FA.

This section attempts to develop methods to make the enemy's will more tangible and therefore vulnerable to FA. It uses an analogy between conventional state warfare and a hostage situation to develop some general propositions related to three general areas of effects: physical, systemic, and psychological.

Trinity of Will

One of the problems with coercive FA is the difficulty in identifying methods to affect an opponent's will. In its most idealized form, coercive FA would consist of a purely psychological solution (i.e., the most idealized FA is no FA at all). This is a Sun Tzu kind of construct in which one would simply intimidate the opponent psychologically, so the contest would never be joined.[26] This study's trinity-of-will construct is an attempt to identify a means to act upon an opponent's will.

The trinity-of-will concept holds that an adversary's will exists in his body, support systems, and mental-moral being.[27] These components of will can be associated with physical, systemic, and psychological effects. Taking this concept further, one can make an association between the adversary's will and the major functional areas of war. The physical component of will can be associated with the actual war-making capacity of the opponent. The support-system component of will can be associated with the adversary's essential systems of war sustainment. Last, the mental-moral component of will is associated with the actual collective will of the opponent (see table 15).

Table 15

Trinity of Will

Will Component	Associated Effects	Associated Resistance
Physical (body)	Physical (material effects)	War Making
Systemic (support systems)	Systemic (functional effects)	War Sustainment
Psyche (mental-moral being)	Psychological (psychological effects)	War Willingness

The intent of the trinity construct is to increase insight into the material basis of an opponent's will. Because an opponent's will is so elusive, lacking a material basis, it is difficult to target. An individual will is derived in part by the condition of its body and those systems that support its needs. All the individual will in the world does not matter if one's support systems are disabled or, obviously, if one ceases to exist (physical elimination).[28] Similarly, if the state's essential support systems are disabled or, as a last recourse, its physical means of resistance are eliminated, then its will should follow.

A Criminal and Hostage in a House

To illustrate the concept of acting on an adversary's will physically, systemically, and psychologically, one should consider the following analogy. Coercing an adversarial state to submit to our demands can be thought of as resembling the coercion of a criminal with a hostage in the house. The criminal represents the government and military of the adversarial state; the house represents the economy, infrastructure, and captured

territory of the state; and the hostage represents the occupied state's civilian population at risk in the crisis.[29]

Isolation. The first order of business is to isolate the criminal and the house. In the law-enforcement case, this is done by creating a perimeter and securing it. On a state scale, FA achieves this by blockade and all other means to isolate the adversary. Given the premise of an isolated criminal, coercive efforts to rescue and secure the hostage and restore the status quo with the least amount of force can begin.

Psychological Efforts. Coercive efforts can be thought of as ranging from idealized to pragmatic, from talking the criminal out of the house to killing him. The first effort in what will progress from psychological to physical is an attempt to negotiate with the criminal. Essentially, attempts are made to talk the criminal out of continuing the siege and to make clear what the future holds. The principal force brought to bear is psychological pressure. On a state scale this is done by moving forces into place while continuing diplomatic negotiations with the adversary state.

As Schelling points out in *Arms and Influence,* if the future contest were not in doubt by the antagonists, one wonders if the contest would take place.[30] Sometimes the criminal, in a logic and reason all his own (and in some doubt about the contest), does not yield to negotiation and psychological inducements.[31] In this case, the coercion efforts must then escalate to systemic or even physical means of influence.

Systemic Efforts. In a sense, denying the criminal the systems he relies on within the house is a further form of isolation.[32] Usually, the electricity, water, and other essential systems within the house are shut off. The telephone is left on as a means to clearly communicate future intent and to facilitate the continued hope of negotiating a settlement. The effects of shutting off the criminal's systems are increased isolation and reduction of the house's capacity to sustain him. This disabling of the criminal's support systems can be viewed as removing the criminal's ability to control his environment. All of these efforts are accompanied with continuous pressure that prevents the criminal from gaining any rest or sanctuary. On a state scale these efforts are analogous to disabling the state's essential functions and reducing its command, control, communications, computers, and intelligence (C^4I) network; infrastructure; critical industries; military logistics; and defense.

Physical Efforts. Usually, except in cases where the criminal's resolve is extremely high or he has nothing to lose, the cumulative effects of isolation, reduction of essential support systems, lack of control, fatigue, and psychological stress are sufficient to force some form of negotiated resolution.[33] However, if a solution is not reached, then coercive efforts escalate to the last recourse of physical displacement. This physical displacing can take many forms, from gassing the criminal out into the open, firing a sniper's bullet, or storming the house. Physical removal of the criminal usually entails high collateral risk to the hostage and the house in terms of injury and damage. In state coercion, these efforts are analo-

gous to the actual physical displacement of the adversary from the area of interest, usually effected by attrition and annihilation of his armed forces.

Basic Propositions. Although this analogy to a state is simplistic, it may convey some basic propositions that can be associated with the three areas of effort. The propositions developed from this analogy can be related to the overall levels of effort, enemy resistance, destruction, and public disapproval potentially experienced during such an event (see figure 18).

Areas of Effort	Level of Effort	Level of Resistance	Level of Destruction	Level of Public Scrutiny
Physical				
Systemic				
Psychological				
	Increases	Increases	Increases	Increases

Figure 18. Areas of Effort Related to Various Levels of Experience

Level of Effort and Resistance. As one progresses in coercive efforts from psychological to physical, the relative level of one's own effort increases. That is, it takes more effort to assault and displace a state's military forces than to negotiate a settlement with its leaders. Conversely, as one's own level of effort increases, the adversary's level of resistance increases. This is due in part to the increasing value the adversary places on maintaining essential systems and sustaining economy and state.

Level of Destruction. As the main area of effort moves from the psychological to the physical, the amount of physical destruction, functional disruption, and death increases. Obviously, systems can be rebuilt in time, but lives cannot be replaced. Hence, the relative level of destruction increases as one moves from the psychological to the physical area of effort.

Level of Public Scrutiny. The last proposition deals with one's own domestic concerns related to military actions. As military efforts move from presence to limited actions to full-fledged operations, the relative level of public scrutiny and concern increases. The public increasingly becomes concerned not only about its own blood and treasure but about the adversary's (to a lesser degree) as well. Because of the increasing level of destruction associated with escalating actions, moral concerns also increase as the area of effort moves from psychological to physical.

A synthesis of this chapter's discussions on coercion, as well as earlier discussions on effects and strategies in this study are outlined in the following composite matrix. The shaded areas in the matrix represent associations developed in this chapter.[34] The unshaded areas are associations developed earlier in this study (see fig. 19).

One association that requires more clarification involves three new terms to describe basic strategic choices. The terms are an attempt to simplify FA strategy into three fundamental choices of *isolating, reducing,* or *displacing* an adversary. These basic strategic choices can be associated

BRUTE FORCE ← Continuum of Force-Application Choices → **COERCION**

PHYSICAL	**SYSTEMIC**	**PSYCHOLOGICAL**
Material destruction	*Functional disablement*	*Will reduction*
Displace	Reduce	Isolate
Destroy, kill, damage, stun, incapacitate, injure, and trap	Delay, disrupt, divert, deny, dislocate, interrupt, neutralize, halt, overload, paralyze, and collapse	Shock, demoralize, stress, and create: fear, fatigue, doubt, uncertainty, mistrust, and disharmony
← **Increasing level of effort required** →		
← **Increasing level of resistance** →		
← **Increasing destruction/irreversibility** →		
← **Increasing level of public scrutiny/moral concern** →		
Targets: armed forces	**Targets:** JWAC's seven competencies: EP, POL, LOC, TELECOM, critical industries, commodities, and military logistics	**Targets:** government and military leadership, at all levels of control (strategic, operational, and tactical)
War Making	**War Sustainment**	**War Will**
Annihilation and Attrition		
	Attrition and Virtual Attrition	
Military	**Economy//Infrastructure**	**Government//People**
Criminal's body	***House***	***Criminal's mental-moral being// Hostage***

PRAGMATIC ← Continuum of FA solutions → **IDEALISTIC**

Legend:
EP–electrical power
FA–force application
JWAC–Joint Warfare Analysis Center
LOC–lines of communications
POL–petroleum, oil, and lubricants
TELECOM–telecommunications

Figure 19. Composite Matrix of Associations to Coercive Force Application

with the historic strategies of blockade (isolate), bombardment (reduce), and invasion (displace).[35]

Matrix Main Points. The main points to take from the matrix are that choices for FA can be selected along a continuum between coercion and brute force; these same choices can also be represented as seeking an ideal solution or a more pragmatic one to FA. Ideal coercion has a pure psychological solution with little or no direct force required. At the other extreme, nothing seems more certain to succeed than overwhelming brute force.[36] There is always a tension between these two extremes in warfare. Accordingly, there is need to make trade-offs between idealized efforts and pragmatic ones in order to balance overall FA efforts. The tension really

describes an unending quest to seek greater effectiveness in warfare and greater economy of one's own efforts and forces. If the more idealized FA plan has a reasonable rationale and chance of working, it should be pursued. But idealized solutions usually have attendant increases in risk.[37] The more complex the systems being acted on, the less predictable the effects, but the greater the potential for disproportionate outcomes as well. Alternatively, the less complex the systems and effects sought, the lower the attendant risk; however, the outcomes are usually proportionate to the level of effort. As a very rough analogy, this trade-off in effects risk is the difference between hitting singles all day in a baseball game or swinging for the fence.[38]

Summary

Effective coercive FA may use more than one strategy. It should integrate the strategies of denial, punishment, risk, or decapitation as required. Coercive FA, recognizing the uncertainty of assumptions, should proceed heuristically—successively checking FA results through mission assessments to regulate future actions. The fundamental basis of coercive FA is that it takes less effort to destroy some things and get an adversary to capitulate than to destroy all things and annihilate an opponent.

Because of the inevitable uncertainty concerning an adversary's motivations and behavior, one's actions to influence his behavior should be framed more in terms of probabilities than certainties. Because coercive FA is neither easily understood nor accomplished, FA planners should remain flexible in their plans and strive to obtain available feedback on the progress of their efforts.

Attacking an adversary's will may be achievable indirectly by attacking the enemy's functions of war making and war sustainment. However, because of the uncertainty of attacking the enemy's will and measuring progress in reducing will, FA planners should balance their overall FA efforts. If one considers attacking will an idealized application of force, that effort should be balanced by more pragmatic applications than directly attacking the opponent's means of resistance.

Notes

1. Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966), 33. See also David A. Deptula, *Firing for Effect: Change in the Nature of Warfare* (Arlington, Va.: Aerospace Education Foundation, 1995), 8.

2. Schelling, 5. This is essentially borrowed from Schelling's development of what he holds as the alternative to coercion.

3. Thomas P. Ehrhard, *Making the Connection*: *An Air Strategy Framework* (Maxwell AFB, Ala.: Air University Press, 1996). This framework is in part borrowed from this work. I have supplemented it primarily with my own ideas on effects and moved domestic and third parties from considerations within the framework to contextual elements outside the frame.

4. This process of organizing objectives into a hierarchy (strategies to task) and maintaining their congruence (Z Diagram) was discussed in chap. 2. The STT concept is attributed to Glenn Kent of RAND. Kent's adapted scheme of organizing objectives-to-tasks-to-targets is the dominant process in practice in airpower-planning staffs today. In my opinion, it is necessary, but it encourages too much science and too little art. In other words it contributes to a false general air of certainty.

5. It is my belief that FA's evolution and refinement is directly related to how well we can develop and express these mechanisms—essentially, how well we can make the connections between what we are acting on and what we believe will be the outcome of those actions. These mechanisms, these beliefs of cause and effect are behaviorally based, but we are acting on them through material destruction, which is addressed in this chapter.

6. Robert A. Pape, *Bombing to Win* (Ithaca, N.Y.: Cornell University Press, 1996). Pape's work is intended as a critique of the efficacy of strategic air attack. However, his general thought and strategy categorizations can be expanded to FA from his specific work on airpower.

7. Carl von Clausewitz, *On War,* ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 77.

8. Donald M. Snow and Dennis M. Drew, *From Lexington to Desert Storm* (Armonk, N.Y.: M. E. Sharpe, 1994), 8.

9. Pape, 69–79. A subtheme that runs throughout Pape's work is the idea that we (USAF) pay far too little attention to assessing the opponent's strategy and then acting to counter that strategy. I think this idea has some substance and merit. We should seek a balance and do both—dispose of the enemy's plan (deny his strategy) and impose our plan (assert our strategy). This last idea is developed in chap. 8 on the basic fundamentals of strategy (see table 16).

10. The strategy of denial is not new. It is the old continental land-power construct renamed. The continental school opined that the surest path to victory is overcoming the adversary's forces. Schelling discusses this same strategy as the dominant convention in both world wars (p. 16).

11. Wallace J. Thies, *When Governments Collide* (Berkeley, Calif.: University of California Press, 1980), 347. This raises the issue of being able to identify who "the opponent" is. Who are the key *valuers?* It is important to properly identify who is driving the *valued* criteria within the state. See also Schelling, 175.

12. Pape, 66–69. Indeed, Pape himself titles his discussion of a risk strategy with a direct reference to Schelling.

13. Pape, 79–86. C^3 has evolved in the military lexicon since Operation Desert Storm, and in Pape's writing of *Bombing to Win,* its new parlance is command, control, communications, *computers,* and *intelligence* (C^4I).

14. Better stated, this coercive formulation would assert that by denying the enemy's objectives, one lowers his expectations of success. By destroying what the enemy values, we raise his costs. Therefore, the enemy's expectations of benefits are lowered as we simultaneously raise the costs, hence, his overall cost versus benefit calculus is negative.

15. A discussion of the interpretations and reasoning Pape applies in his case studies is outside the scope of this study.

16. This sense of certainty was the pervasive attitude at a recent air and space operations center (AOC) Blue Flag exercise that the author attended. The exercise was with Twelfth Air Force at a forward AOC located at Hurlburt AFB, Fla., in November 1997. The exercise experimented with a split AOC concept, looking at placing FA planners forward and intelligence and other major planning assets in the rear area. An unpublished School of Advanced Airpower Studies thesis from this class by Maj Lee T. Wright addresses the split AOC concept. Additionally, this helps to illustrate the tension discussed earlier in chap. 2 between an established linear approach to warfare and an emerging nonlinear one. To be fair, the other side of this coin is that few commanders will tolerate ambivalent or indecisive FA planners.

17. Thies, 219–20 and 417. Thies alludes to how little we knew about our enemy in Vietnam, its leaders, and their motivations. The tendency was for strategists to forecast model-one behavior versus models two and three (Allison's models, see endnote 20). It is my contention that we are equally guilty of this today. We still do not do an adequate job of assessing an enemy as a behavioral composite in a sufficient manner to be able to act and manipulate his behavior. See also Pape, 189.

18. Ibid., 347–48.

19. Graham T. Allison, *Essence of Decision* (New York: HarperCollins, 1971), 32, 78, and 162. Allison develops three models for decision making that explore different influences and rationales to decision making. The pages cited are a quick reference to Allison's models. The composite influences mentioned here refer to Allison's models two and three, and a notion of singular influence refers to model one.

20. These assertions were developed in chap. 4. Effects become increasingly more difficult to predict the longer their cause-and-effect chains and the greater the complexity of the system they are intended to act on. Measuring effects and effectiveness is difficult due to the vulnerable seams in the FA-process set (see chap. 4, fig. 11). Within an FA set intended effects may not actualize, and the intended effects may not translate to influence.

21. Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey: Summary Report* (Washington, D.C.: Government Printing Office, 1993), 55–56.

22. Allison, 256. Instead of Allison's "black box" of decision making, we have the black box of targets-to-effects-to-outcome making. In most instances FA sees the initial effects from the weapons—the battle impact assessment—but after that we are largely in the dark concerning follow-on effects. These follow-on effects (second-order and third-order effects) are in many cases the real intent of the FA, yet we have little assessment of them. Given this condition, it's as if the follow-on effects were occurring within a black box.

23. Derek Wood and Derek Dempster, *The Narrow Margin: The Battle of Britain and the Rise of Air Power, 1930–1940* (Washington, D.C.: Smithsonian Institution Press, 1961), 256–57 and 282.

24. This is a hallmark of a nonlinear approach to warfare to frame FA potentials in terms of trends and probabilities instead of certainties.

25. The strategies of attrition and virtual attrition were primarily developed in chap. 4. As a caveat, the prescription for hedging strategies has some drawbacks: one may not possess enough resources to do both strategies effectively, and spreading the resources may gain one the problems of both and the benefits of none.

26. Sun Tzu, *The Art of War,* trans. Samuel B. Griffith (London: Oxford University Press, 1963), 77–79. "To subdue the enemy without fighting is the acme of skill." "Thus, those skilled in war subdue the enemy's army without battle. They capture his cities without assaulting them and overthrow his state without protracted operations."

27. John R. Boyd's "A Discourse on Winning and Losing" (August 1987) is a collection of unpublished briefings and essays. (See Air University Library, document no. M-U 30352-16 no. 7791, 133.) The term *mental-moral being* is borrowed from his term *moral-mental-physical being.* The intent of the term is to capture both the cognitive and moral dimensions of will in one term. Additionally, Boyd probably derived his term from J. F. C. Fuller's, *The Foundations of the Science of War* (London: Hutchinson and Co., 1926), 62.

28. This proposition is not a law; there are examples of people's support systems being seriously disabled but still able to persevere through strength of will. However, as evidence that reducing support systems does have a reductive effect on will, see *The United States Strategic Bombing Surveys: Summary Report (European War)* (Maxwell AFB, Ala.: Air University Press, 1987), 11–12.

29. One can also speculate that in the case of a totalitarian state in which the people are not in accord with the ruler's interests for territorial aggrandizement, they are hostages themselves.

30. Schelling, 12.

31. A forthcoming work by Steven Rosen at Harvard develops a new characterization of rogue-state leaders. Apparently, Dr. Rosen offers that in the new world order, instead of thinking of these leaders as statesmen, a more appropriate profile may be that of criminals. This new psychological profile develops the leaders as risk lovers living on the edge, with an outlook that favors the short term over the long term. The point of all this is that the reasoning we may be dealing with is more akin to a criminal's than a statesman's, but we are probably mirror imaging to a statesman. Citing this observation by Rosen does not imply that he supports the analogy's broader interpretations of a criminal and a state.

32. By invoking Deptula for a moment, one sees that this denial of the enemy's systems is a type of control through negation. By disabling the enemy's systems, one is at the same time removing the adversary's control over those systems.

33. Schelling, 86. Schelling is discussing this subject in terms of leaders within a state forcing an escalated resolution. Importantly for a theory of coercive FA, this sentence describes the mechanism.

34. The following caveat applies to the matrix. The matrix is helpful for illustrating some general effects and relational associations to form some composite categories for rough FA guidance. The columns however, should not be strictly interpreted as distinct categories with neatly organized and immutable boundaries. The columns are in fact very porous and not exclusive. As stated earlier, most FAs have a component of all three effect areas—physical, systemic, and psychological. The intent is to illustrate the predominant effect area and various criteria that can reasonably be associated with it, given propositions developed in this study. Specifically, the matrix does not exclude the idea that an enemy's armed forces can be influenced with systemic and psychological efforts anymore than it excludes the concept that an enemy's government can be influenced by direct physical efforts.

35. Ibid., 16–17. Schelling discusses two of these three directly—blockade and strategic bombing (bombardment); the third he alludes to as "military victory." The classic examples of these strategies are the German submarine blockades (isolation) of England in both world wars, the Combined Bomber Offensive (bombardment) against Germany in the Second World War, and the Allied invasion (displacement) at Normandy during the Second World War.

36. This is, essentially, one of the tenets of the (Caspar) Weinberger/(Colin) Powell Doctrine (of US military, foreign intervention in major hostilities).

37. This phenomenon was developed in chap. 4 in the propositions developed with complex systems and intended effects.

38. Taking this analogy probably further than is wise, one can venture yet another proposition. It is all right to let coercive FA keep swinging for the fence, provided other pragmatic FA efforts balance this by hitting singles.

Chapter 8

Framework for a Systems-and-Effects-Based Approach

The process of planning for effects is complex. Planners in conjunction with intelligence must determine which effects on each enemy system can best contribute to the fulfillment of the military and political objectives of the theater campaign. . . . An effective plan must extract maximum impact from those systems—not in terms of absolute destruction of a list of targets, but in terms of effects desired upon target systems.

—David A. Deptula
Firing for Effect

This study has discussed a variety of subjects that relate to military strategy and FA planning. The focus of the discussion on FA planning has been twofold, dealing with how to think in terms of effects and how to integrate a systems-and-effects-based approach into FA planning. This chapter outlines general FA-planning considerations, integrating all the elements discussed earlier into a composite methodology. Before outlining the FA-planning methodology, however, some basic principles of strategy must be developed.

Strategy

In warfare and preparations for war, two basic tracks run concurrently in military strategy. One track represents the imposition of our will upon the enemy; the other is the enemy's imposition of his will upon us. In chapter 2, this idea was represented by complexity theory as two coevolving, interacting opponents.[1] This description is fitting: warfare is not characterized by each side taking turns but by both sides acting simultaneously.

Given warfare's fundamental interactive nature, a prime consideration is not only the imposition of our strategy but also the negation of the opponent's strategy. The ability to balance FA efforts between imposing or negating strategies is primarily an act of military judgment.[2] Ultimately, FA planners want to exploit opportunities discovered and created with the opponent, while at the same time protecting themselves from the opponent's threats by denying and controlling his ability to impose his strategy. This duality of strategy is illustrated in table 16.

Both friendly strategy and enemy strategy are equally subject to the laws and dynamics of what can be termed a universal set, which acts upon, reacts to, and, at times, preempts both strategies. In part, warfare can be thought of in terms of both sides continually attempting to exploit and control these universal elements to their favor.

Table 16

Fundamental Duality of Strategy in Warfare

Create **Friendly Strategy**	**Universal Set**	***Negate*** **Enemy Strategy**
Our Strategy	Time and Space	Their Strategy
Our Plans	Geography	Their Plans
Opportunity	Human Nature	Threat
Exploit	Cause and Effect	Protect/Deny/Control
Offensive	Chance	Defensive
Control via Creation	Uncertainty	Control via Negation
Impose Our Plan	Fog and Friction	Dispose of Their Plan
Positive Object	Weather	Negative Object
Persuade		Dissuade

The implication of this fundamental construct on strategy is the importance of considering not only one's own strategy but also that of the enemy. There is a tendency for friendly strategy to become overly focused on the imposition of its own objectives at the possible expense of addressing and balancing efforts to counter the enemy's objectives.[3]

Planning Framework

The planning framework presented here is developed from previous discussions concerning strategy and planning. The framework is presented in two parts.

General Methodology

The first part of the planning framework is a general overview of the methodology without detailing the role of effects. The second part concentrates on the place that effects fill within the methodology and expounds on their role within the overall FA-planning framework.

Imperatives and Objectives. In military strategy, as in most complex endeavors, there is a need to distinguish the essential from the unessential and to do first things first. Examples of such imperatives might be a need immediately to stabilize a vulnerable battlefront or to establish and maintain air superiority.[4] Along with imperatives, FA planners must direct their plans to accomplish the objectives. STT is an excellent tool to organize planners' efforts and to ensure congruence between the various levels of objectives.[5]

Centers of Gravity and Leverage. The principal means to act on an opponent is developed by assessing the opponent in terms of COGs and leverage. The ideas of COGs and leverage are closely related; both describe a potential to strike a critical part of the enemy and have a disproportionate effect upon the whole.[6] COG and leverage analysis help generate effective military objectives and tasks; these in turn help fulfill higher-level objectives economically.

View the Enemy Holistically and Systematically. FA planners using systems analysis should strive to view the enemy holistically in order to realize opportunities to affect the enemy as a whole. By assuming a holistic perspective, FA planners increase their ability to recognize effects that can be produced and distributed across several interrelated systems with selective FA. The benefit of generating distributed effects across multiple interconnected systems is synergy and economy of effort. An example of holistic thinking aiding FA planners against complex systems is drawn from the British side of the CBO during the Second World War.[7] In late 1943, Air Chief Marshal Sir Arthur Tedder and Solly Zuckerman examined the strategic problem of how best to achieve the dual objectives of reducing the war-sustaining capacity of the German war economy and reducing the war-making capacity in the planned invasion region. Their solution was novel, but it was anathema to both Sir Arthur Harris and Gen Carl A. "Tooey" Spaatz.[8]

Zuckerman's academic expertise was zoology, which provided an orientation from which "Zuckerman looked at problems as wholes and considered their individual components as parts of a complete organism."[9] The complete organism that Zuckerman and Tedder assessed was the whole German war machine. The key to their problem-solving process was to view the German economy and the western German defense forces in the planned invasion region as two systems. They then looked for a interconnected system, a "common denominator," shared by both systems.[10] The system they set upon was transportation. They correctly reasoned that by attacking the transportation system, they could disrupt and impede resources to both defense forces and economic functions.

JWAC's seven-system competencies are a good place to start for viewing the enemy systemically.[11] A behavioral analysis of the enemy would complement this material analysis, investigating the enemy's decision making, stakes, interests, motivations, and its leaders' relationship with the ruling elite, military, and people.[12] The key product to be derived from this analysis would be insights into how to potentially influence the adversary's behavior.

Selecting mechanisms would be a new and critical step within current FA planning; while it has been done in the past, it has usually not been done consciously or deliberately. Mechanisms, whether explicit or implicit, are the basic cause-and-effect assumptions supporting a given FA strategy. The mechanisms that FA planners use in developing basic strategy should be founded on several factors: history, doctrine, logic, analysis, and, to a lesser degree, intuition, faith, and hypothesis. Planners should explicitly declare the mechanisms they are using in order to be clear about the assumptions upon which they are founding their strategy.[13] The exceptions to this explicit declaration of a mechanism occur when the assumptions are based primarily on intuition or faith. By definition these forms of reasoning are implicit and difficult to articulate and justify.

Conventional warfare often comes down to three fundamental tasks in the overall effort to compel or conquer an enemy: to isolate, reduce, and

displace the opponent. Isolating an opponent is sought by means of alliances, blockade, embargo, and international condemnation. Reducing an opponent has been achieved through blockade, siege, and bombardment. If, after isolating and reducing an opponent, he still has not capitulated, a final task is displacing the opponent. An opponent is typically displaced from an area of dispute by land invasion and combined-arms assault. These three fundamental tasks are a top-level means for FA planners to regain perspective when the complexities of the FA efforts begin to melt together.

Effects. Overall military strategy and objectives are developed to support and fulfill national objectives. Once the military objectives are established, effects planning can begin. By selecting various mechanisms, one develops overall schemes for influencing the enemy and fulfilling military and national objectives. Once the mechanisms are understood, intermediate effects can be planned to achieve the objectives.

The pairing of objectives to effects begins with FA planners determining what intermediate results are required in order to fulfill specific objectives (or to partially fulfill related or multiple objectives).[14] By working through the various objectives, one can systematically plan and pair the desired effects with their associated objectives. There is potential to find unexpected linkages between seemingly unrelated objectives by examining systems' objectives that they may have in common. These common-shared systems can then be exploited through distributed effects to fulfill both objectives, resulting in economy of effort.

Once objectives and their related effects are paired, appropriate targets can be planned to achieve the desired effects. Targets, as the initial triggers that produce the effects, which in turn fulfill objectives, are vital to the FA process. FA planners must not only consider first-order effects (from destroying targets) but more importantly the downstream resultants from the destruction (second-order effects). It is the successful crafting of these second-order effects that represents the real challenge to FA planners.

Force-Application Set and Process. An FA set is a discrete and coherent cause-and-effect chain linking specific objectives and effects to selected targets. Once a specific FA set is established, the strategy can be executed. A given FA set may or may not be successful in fulfilling its objectives and may need adjustment. Therefore, an FA set is best thought of as a heuristic process.[15]

Obtain Feedback. After force is applied, results from the attacks need to be measured and assessed to see whether or not the planned effects are actually being achieved. This assessment is problematic because many planned second-order effects may not have a sufficient material basis to allow for easy measurement.

Measuring indirect effects requires developing new techniques as well as improving current ones. Some possible techniques would be to design indicators that can reveal whether or not a particular system is functionally disabled. For example, before attacking a critical C^3 node, some kind of electromagnetic device could be placed (physically or electronically) in

a position where it could monitor, detect, and communicate any disruptions it measured. Existing techniques using HUMINT and intercepting the enemy's own battle-damage-assessment communications could be improved by increased emphasis.[16]

The basic measures sought in an assessment of effects and effectiveness are whether the planned effects occurred and whether the generated effects translated to influencing the intended objectives. These questions essentially represent the seams in the FA-process chain where disconnects in cause and effect can occur, and the overall coherence of the FA set can break down.[17]

Regulate Future Action. The various planned FA sets are the best plans (hypotheses) available based on assumed mechanisms and objective-to-effect-to-target couplings. But FA is essentially a process and, as such, must be adjusted. Not every FA set (as a miniature cause-and-effect experiment) will be successful. The best way to determine which actions to reinforce and exploit and which sets to modify or terminate is to obtain feedback.

Analyzing results of after-action measurements can be extremely problematic. For example, if a particular FA set does not appear to be effective, is it because the wrong target was struck, producing the wrong effects, or was it the right target, but the effects did not translate to influence? It is also possible to strike the correct target and achieve the planned effects but have a faulty mechanism that incorrectly assumes the effects will have a decisive influence on a particular objective. Given an overall framework for pursuing a systems-and-effects-based approach to FA, it is appropriate to examine the role of effects in a system.

Specific Effects Methodology and Considerations

The basic reason for inserting effects as a deliberate planning consideration between objectives and targets is to improve the overall efficacy of the FA process. Effects help bridge the cause-and-effect gap between objectives and targets by forcing an articulation of the intermediate results required to fulfill the objectives. Planning effects before considering targets contributes to a perspective in which targets are viewed as a means of influence, not as ends in themselves.

Systems and Effects. Most FA objectives can be related to one or more enemy systems, and these systems are in turn considered in FA planning. A basic premise of FA effects is that their characteristics derive, in part, from the nature of the system they are generated from. Given this premise, FA planners can assume some general propositions relating to effects based on the relative complexity of the system being attacked.

Some basic principles of effects can be developed from examining the relative complexity of the systems involved. A comparison of simple and complex systems and principles of effects related to them is illustrated in table 17. Planning for effects against simple systems is usually more straightforward than against complex systems. This basic difference is due to the difference in connectivity and interaction between simple and

Table 17

Simple and Complex Systems

Simple Systems	Complex Systems
Low interconnectivity and interaction	High interconnectivity and interaction
Basic structures	Intricate structures
Short cause-and-effect chains	Long cause-and-effect chains
High predictability	Low predictability
Straightforward effects	Perverse (complex) effects
Effects usually immediate	Effects often delayed
Proportionate effects (linearity)	Disproportionate effects (nonlinearity)

complex systems. In general, the more intricate the system being attacked, the more uncertain and complex the effects. Additionally, as the complexity of effects increases, the time required for their generation from the attack increases.

A basic trade-off occurs in planning between complex effects (with higher-impact potentials and disproportionate results) and simple effects (with lower impacts and more proportionate outcomes). This trade-off, however, is not straightforward because while the potential benefit of complex effects is relatively high, their predictability is low compared to simple effects.

Effects Risk. The basic trade-off in planning for effects actually describes a difference in risk between simple and complex effects. Simple effects have lower risk than complex effects because their potential to achieve the intended effects is higher. An example is a weapon causing destruction of a target. In contrast, second-order effects are riskier, such as a weapon destroying a target, which in turn causes the functional disruption of a system, delay of troops, or demoralization of the enemy.[18]

Objectives drive the planning for effects, and FA planners can anticipate planning against both simple and complex systems to accomplish objectives. Planners may not have a choice between affecting a system directly or indirectly. As a rule of thumb, the more indirect the planned effect, the longer its associated cause-and-effect chain and the less certain its outcome; and the more direct the planned effect, the shorter its cause-and-effect chain and the more certain its outcome.

Effects and Levels of War. Most objectives can be associated with one or more levels of war. Given this premise, the effects subsequently planned to achieve an objective can be associated with the objective's level of war. Some basic associations of effects and levels of war are outlined in table 18.

Effects associated with objectives at the tactical level can usually be achieved directly and quickly by destroying the associated targets. When planned effects are associated with objectives at higher levels of war, their attainment usually becomes more indirect and delayed because they occur after and as a result of the destruction of the targets. Targets asso-

Table 18

Effects and Levels of War

Level of War	Relative Complexity of Systems	Relative Rate of Effects	Relative Duration of Effects
Tactical	Simple	Immediate	Short
Operational	Median	Intermediate	Medium
Strategic	Complex	Slow	Long

ciated with objectives and higher levels of war are usually a means to generate second-order effects and not ends in themselves.

As a general rule of thumb, as the level of war increases, the time over which the effects develop, mature, and endure increases in direct proportion. Moreover, as one moves from the tactical to the strategic level with planned effects, their relative degree of abstraction increases. This abstraction describes a tendency for the material basis of effects to decrease (and their associated measurement to migrate from quantitative to qualitative methods) as they move from the tactical to the strategic level.

Strategic effects are planned to affect the war as a whole by influencing the major functional areas of war sustainment and war will. SEs focus on COGs associated with functions. They should contribute to reducing and unbalancing the enemy's overall political, military, and economic capacities as well as his collective psychological stability. In general, SEs generate slowly and require a long period to mature fully.

Operational effects are planned to affect campaigns and/or major operations by influencing the major functional areas of war sustainment and war making. OEs focus on COGs associated with an enemy's forces. They should contribute to reducing and unbalancing the enemy's capacity to conduct successful campaigns and war. Most often, OEs generate at a medium rate and require an intermediate period to mature.

Tactical effects are planned to affect individual battles and engagements by influencing the war-making functional area. TEs focus on affecting forces and may not directly relate to a specific COG. They contribute to reducing and unbalancing the enemy's capacity to conduct battles. In general, TEs generate and mature immediately.

Intended and Unintended Effects. Any planned FA yields both intended and unintended effects. These unintended effects can be additive, subtractive, or neutral to the achievement of the intended objectives, either reinforcing the intended effects, canceling them out, and/or leading in a completely unanticipated direction. FA planners must weigh the costs and benefits of pursuing an FA set that is yielding unintended effects. The unintended effects may be so counterproductive to the intended objective or others that further action against that particular system is no longer worthwhile. On the other hand, some unintended effects can be serendipitous and should be exploited.

Summary

Current FA planning can be improved by placing greater emphasis on planning for effects. Conducting such planning before considering targets should facilitate a strategy of influence versus a strategy of destruction. This overall shift in basic strategies is accomplished principally by subordinating targets to effects and effects to objectives. In this shift, targets are no longer ends in themselves but are the initial triggers that cause the rest of the FA process to occur.

Current system and target analysis is robust but could be complemented by an analysis that addresses the nonmaterial and behavioral aspects of the enemy. This could then be combined with the material analysis in an overall scheme that links material modification to behavioral modification. Improving the linkage between material and behavioral modification should lead to economies in overall effort and move the focus of FA towards coercion rather than brute force. However, because coercion is an idealized solution, it is often difficult to achieve; therefore, more pragmatic approaches that employ the added persuasion of overwhelming force are usually a useful hedge for the strategist.[19]

FA is better thought of as a process than as a procedure. Outcomes from any given FA set are uncertain and may need to be modified, based on feedback. FA should expect its share of failures, but, given sufficient feedback, ineffective FA sets can be adjusted heuristically to achieve future effectiveness.

Notes

1. Steven M. Rinaldi, "Complexity Theory and Air Power," in *Complexity, Global Politics, and National Security,* ed. David S. Alberts and Thomas J. Czerwinski (Washington, D.C.: National Defense University, 1997), 258.

2. Carl von Clausewitz, *On War,* ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 101–12. Clausewitz's paradigm to reconcile all the chance, uncertainty, fog, and friction of war was military genius. Genius alone aided by natural intellect and grounded in a sound understanding of military history could see what was true and necessary within the chaos of war and the moment and judge correct actions (military judgment). The military cannot count on creating and/or having geniuses in the right place at the right time, so in lieu of this it needs to create a genius of understanding concerning the nature of war and strategy.

3. Robert A. Pape, *Bombing to Win* (Ithaca, N.Y.: Cornell University Press, 1996), 69–79. Pape's denial strategy addresses this idea of thwarting the enemy's plans and objectives. However, Pape exclusively confines the means of this negation to efforts that deny the enemy control and use of his military forces. He reasons that enemy objectives are principally realized through the use of his armed forces; therefore, by removing those forces, one has effectively removed the enemy's means to his objectives.

4. Richard T. Reynolds, *Heart of the Storm: The Genesis of the Air Campaign against Iraq* (Maxwell AFB, Ala.: Air University Press, 1995), 75 and 127. This very idea of missing an imperative (at a tactical and operational level) and talking too early about follow-on actions (at the strategic level) is what in part infuriated General Horner when he heard Colonel Warden's Instant Thunder briefing at Riyadh in August 1990. The imperative that General

Horner perceived was the need to halt an imminent land invasion by Iraq into Saudi Arabia. Colonel Warden, on the other hand, continued to look past this near-term imperative and to discuss Iraq in terms of a static foe susceptible to strategic attack. See also J.C. Slessor, *Air Power and Armies* (London: Oxford University Press, 1936), 78.

5. Strategies-to-task does a good job of organizing friendly objectives but does not incorporate considerations of enemy objectives in a deliberate manner to work the other track of strategy.

6. Leverage also suggests asymmetrical aspects in its definition that describe strength on weakness and dissimilarity in opposing forces.

7. Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, N.J.: Princeton University Press, 1997), 19.

8. Alfred C. Mierzejewski, *The Collapse of the German War Economy, 1944–1945* (Chapel Hill, N.C.: University of North Carolina Press, 1988), 80–85.

9. Ibid., 81.

10. This is essentially the same mechanism that ACTS developed. It involves the idea of looking for a common vital function within a complex system (industrial web theory) that, when acted upon, would affect the whole system. Sir Arthur Tedder and Solly Zuckerman extended this idea to a common function shared between two systems.

11. Previously recommended additions to the seven competencies are C^4I and leadership (see chap. 5 and note 10).

12. In the USAF, this behavioral analysis could be colocated with JWAC and would involve bringing in greater representation and expertise in the so-called soft sciences (psychology, sociology, and political science). A psychological analysis of the enemy as a state and particularly of the leadership would be a great tool for developing a rational basis for coercion and behavioral modification of the state (leadership). See also a previous discussion on behavioral analysis in chap. 3.

13. See chap. 2, mechanism declaration. In a sense, declaring the mechanism is recording the parameters of the FA experiment, a declaration of the FA hypothesis. If the experiment (the force application) does not prove out, the hypothesis can be reexamined and the process modified to yield expected results. This process of developing FA and strategy in successive stages describes a heuristic approach.

14. The idea of looking for various effects that will work towards fulfilling multiple objectives is an appreciation of the tendency for effects to become distributed across systems and objectives.

15. It is for this reason, in part, that the air campaign for Desert Storm did not detail an air tasking order beyond the first few days. It was an acknowledgment that strategy and objectives need to evolve based on a changing and evolving environment and enemy. Essentially, FA is best approached heuristically.

16. Diane T. Putney, ed., *ULTRA and the Army Air Forces in World War II* (Washington, D.C.: Government Printing Office, 1987), 36 and 41. Intercepting the enemy's bomb damage assessment has been done in the past; in an attempt to assess the effectiveness of strategic bombing, the Allies did it during the Second World War. The information came from decrypted ENIGMA material code-named ULTRA. Communications were intercepted between Albert Speer, Germany's director of Armament, and military leaders on the status of key industries' capacity for continued war production.

17. Effects and effectiveness were originally developed in chap. 4.

18. Several practical examples of first-order and second-order effects were given in chap. 5. This concept of first-order and second-order effects was also developed in chap. 4.

19. This is another way of saying that the relative effects risk with coercive FA efforts is high compared to effects risk associated with brute force. A balance is required to manage and properly weigh the efforts between these two low-risk and high-risk influence schemes.

Chapter 9

Conclusions and Implications

More than a few analysts could be cited who appreciate that our conceptual equipment needs to be enhanced and refined, that under some conditions non-linear approaches are more suitable than the linear conceptual equipment that has served for so long as the basis of analysis, that the disciplinary boundaries that have separated the social sciences from each other and from the hard sciences are no longer clear-cut, and that the route to understanding and sound policy initiatives has to be traversed through interdisciplinary undertakings.

—James N. Rosenau
Complexity, Global Politics, and National Security

The primary intent of this study has been to explore and advance an alternative FA-planning methodology focused on systems and effects. This study has been written for FA planners of all services at the operational and strategic levels of war. Because of the inherent complexity of warfare and FA planning, it has been necessary in this study to consider strategy, operational art, and systems-and-effects planning together in order to derive useful insights.

Synthesis and General Conclusions

The FA-planning elements used in this study are not new. Objectives, targets, and effects have long been part of FA planning. What is new is deliberately selecting objectives and planning for effects in advance of selecting targets. A systems-and-effects-based approach does not replace a targets-based approach altogether; it supplements it by shifting the focus to planning for effects first, then targets. The basic premise for inserting effects as a deliberate planning consideration between objectives and targets is to improve the overall efficacy of the FA process. Effects help bridge the cause-and-effect gap between objectives and targets by forcing an articulation of the intermediate results required in order to fulfill the objective.

Process and Feedback

Two of the most fundamental insights of this study are that FA planning is best thought of as a process, and that the process requires feedback. Given that knowledge of the enemy is uncertain and FA plans once placed into action are also uncertain, a flexible approach is required to adjust subsequent planning. FA planning that proceeds in successive stages to plan-assess-and-plan provides the required flexibility to respond to a changing foe and environment.

Systems-and-Effects-Based Approach

FA planning begins with objectives, which can be organized according to the three major functional areas of war. Once FA planners have organized the objectives, an assessment is made of how best to achieve them. This assessment leads to a selection of systems associated with the objective and identification of the means to affect a given system. FA planning then moves to developing effects that are linked to the objective and identified systems. These serve as intermediate results between objectives, systems, and targets to help bridge the cause-and-effect gaps.

There is a sound theoretical basis for a systems-and-effects-based approach to FA that stresses planning for effects before selecting targets and emphasizes planning for physical, systemic, and psychological effects as the primary means for influencing an opponent. This study asserts that force can be applied to generate effects within selected systems in order to satisfy linked objectives. The systems that previous theorists have identified as having the greatest influence upon the enemy have varied, but their desire to seek follow-on effects from destruction has not. FA planners would do well to think in terms of functional effects and ways to functionally disable essential systems instead of ways to annihilate those systems.

Force-Application Planning Tendencies

FA planners in the past have tended to underestimate the enemy in three areas. First, they routinely underestimate the will of the enemy to resist. Second, as asserted by Olson, planners have a tendency to underestimate the resilience of industrial economies. Third, FA planners consistently underestimate the time required for functional effects to mature and become effective. Planners must be aware of these three tendencies in order to resist their influence. Useful countermeasures include not relying entirely on breaking the will of the enemy people, looking for tightly coupled systems within economies, and allowing extra time for functional effects to mature.

Planning for Effects

An implied question of this study has been, “Can FA planners reasonably plan for effects?” The short answer is yes, effects can be planned; however, a longer answer requires an examination of the nature of FA cause and effect. This inquiry led to two different models of cause and effect. The first holds that cause and effect in FA is nonlinear, highly interactive, disproportionate, and complex. This is accurate but not complete. The second model asserts that cause and effect in FA is linear, serial, proportionate, and simple. Both of these images are valid, effects being both simple and complex, both certain and uncertain.

This study also asserts that some target-effect pairings are more likely to yield their intended effects than others are. Effects exhibit greater or lesser certainty depending on the magnitude of the cause-and-effect

sequence required to produce them. Destroying a target in FA is relatively certain.[1] A weapon destroying a target can also illustrate a higher order of cause and effect, the destruction of the target in turn causing the functional disruption of a system. This target-effect pairing is less certain due to the higher magnitude of cause and effect required.

The two explanations of cause and effect, simple and complex, can be related to earlier discussions on frameworks for understanding warfare. The Newtonian and complexity frameworks differ in their accounting of the nature of cause and effect in warfare. The Newtonian framework suggests that effects are relatively straightforward and can be predicted and planned while complexity theory suggests that effects are more difficult to predict and plan. Like the explanations of FA cause and effect, the frameworks are not incompatible. Both the Newtonian and complexity frameworks are needed to account for the full nature of effects experienced in warfare.

Coercive Force Application

Choices for FA range along a continuum between coercion and brute force; these same choices can also be represented as seeking an ideal or pragmatic solution. Ideal coercion as an extreme has a purely psychological solution with little or no direct force required. At the other extreme of FA, nothing is more certain to succeed than pragmatic, overwhelming brute force. There is a tension between these two extremes in warfare, and in FA there is a need to make trade-offs between idealized efforts and pragmatic ones in order to balance overall effort. However, idealized solutions usually have attendant increases in the risk of achieving them. The less complex the systems and effects sought, the lower the attendant risks; however, the outcomes are usually proportionate to the level of effort. Alternatively, the more complex the systems being acted on, the less predictable the effects; however, the greater the potential for disproportionate outcomes.

Strategy

FA planners as military strategists should strive to maintain a flexible outlook about approaches to achieving objectives and influencing the enemy. There may not be just one approach, a single panacea target or mechanism, to ensure success. Two challenges to military strategists are to view the enemy holistically and to apply what seems best fitted to the evolving situation. The shift in FA planning to an emphasis on effects can help meet these challenges. FA planning based on both systems and effects should provide an analytical and integrated perspective to attack the enemy's vital systems, capitalizing on distributed effects and influencing the opponent as a whole. This combined perspective should provide both the specific and general insight required to successfully influence the adversary. Adopting the proper perspective and selecting the appropriate target-effect pairings are vital to successful FA. However, once again, the key to regulating FA and adapting strategy is FA feedback, which provides

the means to measure efforts and determine the effectiveness of present and future actions.

It is important for FA planners to bear in mind that strategy has a dual nature—both the creation of one's plans to exploit the enemy and the need to negate the enemy's plans to exploit one's own forces. However, sometimes it is not a matter of assessing and proactively planning to affect or counter the enemy offensively or defensively but an imperative to react to the adversary and thwart his immediate threat.

Because of the uncertainty involved in assessing an adversary's motivations and behavior, our actions to influence his behavior should be framed more in terms of probabilities than certainties. This is a hallmark of a nonlinear approach to warfare.

FA planners provided with objectives can plan using a systems-and-effects-based approach to achieve those objectives. Intelligence-planning staffs and organizations such as the JWAC provide the technical ability required to develop detailed systems analysis of the enemy. FA planners should work closely with these system experts to understand the nature of the systems they are attacking as well as the enemy as a whole. Additionally, FA planners should request available nonmaterial analysis that may exist about the enemy that profiles its behavior. FA planners, thus given an understanding of the nature of the enemy, can determine the effects that will accomplish the objectives. Once the intermediate objectives (effects) have been developed, the planning can move to developing the targets to generate the intended effects. During execution, planners continue to plan, checking results for effectiveness and adjusting targets and effects as required to fulfill the objectives.

Implications

The real potential for a systems-and-effects-based approach to FA is the acknowledgment that a great deal of warfare is nonlinear. Indeed, we find that results in war quite often occur out of proportion to actions. What has been missing from our conceptual framework for FA and effects is a viewpoint that embraces the properties of complexity, interactivity, and connectivity among systems. Complexity theory provides a framework to begin to examine nonlinear effects, addressing second-order and higher-order effects that result from complex interactions and system-to-system linkages. This exploration into nonlinear effects could also help in the development of more realistic and effective mechanisms for FA. If FA planners can develop a deeper understanding of the causal relationships and behavior within and among systems, they should be able to construct better mechanisms to accomplish their objectives.

Another implication related to developing better mechanisms is a proposal to add behavioral analysis to the JWAC's competencies.[2] Behavioral analysis of an opponent can provide insight into the enemy's motivation,

interests, stakes, and mind-set. It can also lead to well-integrated efforts to affect the enemy materially and behaviorally. This integrated analysis should aid the development of more effective FA mechanisms that better link the paradigms of material modification and behavioral modification. Traditionally, material analysis has been informed by the hard sciences, while behavioral analysis has been guided by the soft sciences. The future, as James Rosenau suggests in this chapter's epigraph, is to combine the two sciences in an interdisciplinary approach. The JWAC should take the lead in developing such an interdisciplinary approach for FA.

There is a potential for effects to be used in a larger sense than just FA planning. Defense organizations and decision makers have attempted over the years to find a way to make fair comparisons between differing views on strategic planning, force structure, and budgets. These comparisons have sought unequivocal measures that would be the equivalent to profit and market share in the business world. Effects and the ability to produce effects may provide the basis for such a comparison. By thinking in terms of effects, one can cross service lines (mediums and domains) and focus not on who or what delivered the FA but on the result. This is the whole point of an effects-based approach: to reframe the defense dialogue in terms of effects and a service's ability to contribute to objectives and national defense. Such reframing should serve to clarify the individual service competencies to produce unique and complementary effects, which taken together, create a rich palette for joint operational art.

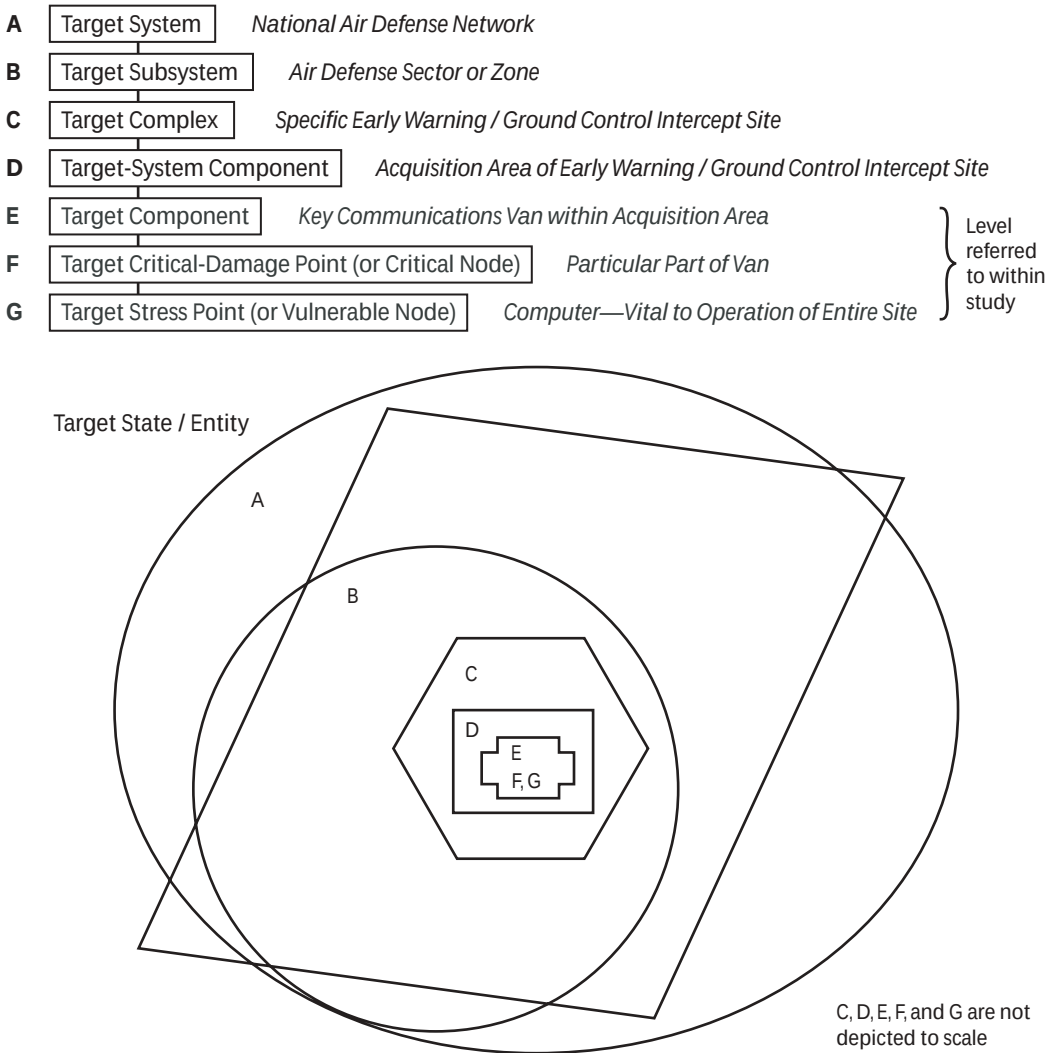
Notes

1. Today, this expectation of destruction with precision weapons and more accurate delivery systems is more certain than in the past. This certainty does not extend to special targets such as those that are mobile or deeply buried—which require special weapons and operations—and are less certain.

2. Additionally, the JWAC should add C^4I and leadership to its core competencies.

Appendix A

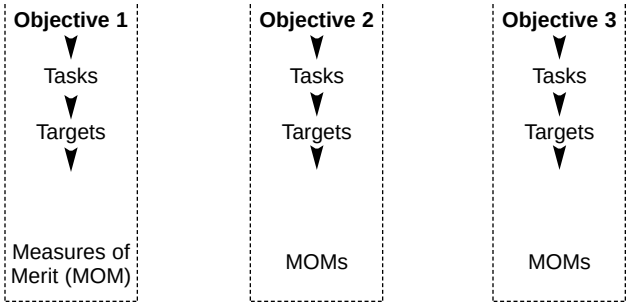
Hierarchy of Target-System Analysis



Appendix B

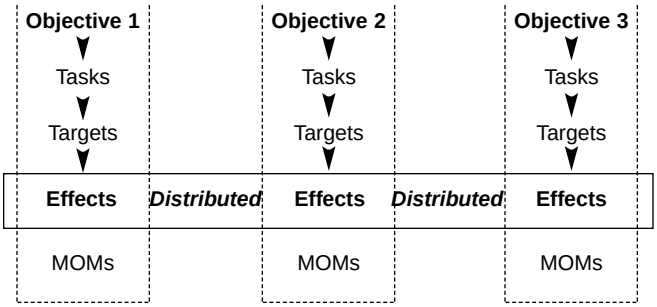
Strategies to Task (STT) and Distributed Effects

STT as Planned



- Methodology organizes objectives, tasks, targets, and MOMs all into compartmented sets (bins).
- Tendency to overcompartmentalize objectives
- Does not recognize and plan for effects
- Linkages between systems and target sets may not get considered due to partitioning of sets.
- In reality, effects, when generated are not isolated within a bin; they propagate within and across bins.

STT with Effects



- Effects often cross over bins.
- Second-order and third-order effects may get distributed due to interconnected and interactive nature of systems attacked (linked).
- By achieving distributed effects, an effects-based approach increases the potential for greater economy of force by attacking linked systems and objectives.

Summary

- STT does not recognize and plan for effects.
- It does not capture the phenomenon of distributed effects or any effect other than damage and destruction (first order).
- This methodology is largely linear, reducing targets in direct proportion to force-application efforts.
- If they are identified, systems are looked at in isolation instead of as being interconnected. Potential leverages for influencing multisystems via critical relationships with other systems are not readily identified.
- Implication: missed opportunities to achieve distributed and disproportionate effects

Appendix C

Levels-of-War Matrix

	Strategic	Operational	Tactical
Scope and scale of interest (JP 3-0)	Theater; war as a whole	Campaign and major operations	Battles and engagements
Systems think	Country as a whole system. Composite of war sustainment, war making, and war will	War-making system, fighting forces, center of hostile ability	War-making components and units
Major functional focus for FA	War sustainment and war will	War making*	
Centers of Gravity	FUNCTIONS: infrastructure, logistics, and will	FORCES: the capacity from which a military force derives its freedom of action, physical strength, or will to fight	
Effects (JP 3-05.5)	Contribute to reducing and unbalancing the enemy's overall political, military, and economic capacities and respective psychological stability (hostile will)	Contribute to reducing and unbalancing the enemy's capacity to conduct successful campaigns and wage war (hostile ability)	Contribute to reducing and unbalancing the enemy's capacity to conduct battles on a relatively localized basis
Time required for effects to manifest	Long term	Midterm	Immediate
Battle and geographic association	Deep or far battle	Intermediate or next battle	Close battle
Traditional airpower mission associations	Strategic attack	Air interdiction	Close air support
Interdiction: goes across levels; where war materiel is interdicted	War materiel at sources (production)	War materiel in transit (distribution)	War materiel in use (operation)
Traditional land-power time horizons	>72 hours	24–72 hours	0–24 hours
	Strategic	**Operational**	**Tactical**

*This is not to say that operational forces do not have aspects of sustainment and will associated with them. Obviously, military forces heavily rely on sustainment, and interdiction capitalizes on this potential vulnerability. So too, military forces have a will of their own that contributes to the overall national will of the adversary. The intent is to simplify the enemy in a macrosystem functional sense to develop general schemes for influencing the opponent as a whole.

Appendix D

Linear versus Nonlinear: Conceptualizations of Cause-and-Effect Relationships

LINEAR	NONLINEAR
Defining Characteristics[1]	
System is linear if it meets two simple conditions	System is nonlinear if it does not display the conditions of linearity
First condition: proportionality; changes in system output are proportional to changes in system input	Disobeys proportionality: changes in system output are erratic, exhibiting disproportionately large or small outputs
Second condition: additivity or superposition; the whole is equal to the sum of its parts	May involve synergistic interactions in which the whole is not equal to the sum of the parts
How Each Conceptualizes Warfare[2]	
Conduct of war is insulated from its context	Conduct of war as a subset of the political context
As a simple binary opposition	As a complex interaction between animate entities that act, react, and even preempt
Tends to ignore Clausewitz's fog, friction, and chance	Allows for incorporation of Clausewitz's fog, friction, and chance
Serial warfare	Parallel warfare[3]
Pros of Each[4]	
—Offers structural stability and emphasis on equilibrium —Rationalizes scaling and compartmentalization —Promises prediction and thus control	—Offers expanded sense of cause-and-effect relationships, embracing complexity theory —Helps with successfully adapting to changing circumstances —Premium placed on flexibility, adaptability, dynamic change, innovation, and responsiveness
Cons of Each[5]	
—Predictions tend to be restrictive, narrow, and brittle —Not very adaptive to significant changes in the environment —Most natural and social systems are not linear	—Generates instabilities, discontinuities, synergisms, and unpredictability —Adaptability is rendered so complex it defies understanding and prediction
Systems and Effects[6]	
Views systems in isolation	Views systems as interconnected and interactive both internally and externally
Effects are isolated within a given system acted upon	Allows for effects to cross over systems and act simultaneously upon multiple systems
Effects are in proportion to their causes	Effects can be disproportionate to their causes
Effects are largely sequential	Allows for effects to occur in parallel
LINEAR	**NONLINEAR**

1. Alan Beyerchen, "Clausewitz, Nonlinerality, and the Unpredictability of War," *International Security* 17, no. 3 (winter 1992/93): 62.
2. Alan Beyerchen, "Clausewitz, Nonlinerality, and the Importance of Imagery," in *Complexity, Global Politics, and National Security,* ed. David S. Alberts and Thomas J. Czerwinski (Washington, D.C.: National Defense University, 1997), 157–59.
3. Steven M. Rinaldi, "Complexity Theory and Air Power," in *Complexity, Global Politics, and National Security,* 288–89.
4. Beyerchen, "Clausewitz, Nonlinerality, and the Importance of Imagery," 161 and 168.
5. Ibid.
6. Rinalidi, 251–53.

Appendix E

Airpower-Theorists Summary Matrix

	Functional Focus of Force Application	Centers of Gravity	Targeted Systems	System Model	Mechanism
Douhet	War sustainment and war will	Forces and functions	Airfields, transportation, supply, and population		Weapons of mass destruction on cities would lead to terror and panic and collapse of civil will
Mitchell	War making, war sustainment, and war will	Forces and functions	Forces, transportation, industry, and will		—Defeat forces —Defeat will —Cripple war industry
Slessor	War making and war sustainment	Forces and functions	Armies, war production, and war supply	Systematic interdiction	Starve war making: interdict war production at sources and war supply
Air Corps Tactical School	War sustainment and war will	Functions	War economy, infrastructure, production, and power	Industrial web (industrial fabric)	Disable vital common functions within economy and critically reduce collective will
Warden	War sustainment and war will	Functions	Leadership, command, control, and communications and economic essentials	Five Rings	Strategic paralysis: induced by critically disrupting command and control function

Appendix F

Systems Approach to Force-Application Planning

Identify Objectives (Political/Military):
Strategies to task
Hierarchical logic of objectives from national (grand strategic), theater (strategic), campaigns (operational), to battles (tactical); [Z diagram for congruence]

Centers of Gravity (source of strength, resistance, resolve, and balance):
Forces: war making
Functions: war sustainment and war will

Leverage Credo:
All wholes are made of parts
Some parts more critical to the whole
Assess and destroy critical part and affect the whole
Affecting a part takes less effort than destroying the whole

Section associated with systems analysis

Systems Analysis (Reductionism [extrasystemic]):
View enemy as a suprasystem (holistic analysis)
Decompose suprasystem into systems (MPES)
Systems into subsystems (seven competencies)
Subsystems into components and elements

Nodal Analysis (Connectivity/Linkage/Causality [intrasystemic]):
Analyze system to identify critical node(s)
Usually a critical component that has a high merit of system linkage
Belief that affecting the component will interact and affect the system as a whole

Criticality and Vulnerability Analysis (Benefit/Feasibility):
Within theater; exposed; able to be acted on (material nature)
Chance of success; probability of destruction
Benefit; payoff of affecting specific system

Tight- and Loose-Coupling Analysis (Recuperability):
Relational dependency of component to system or system to macrosystem
Capacity of system (slack; ability of system to substitute and compensate)
Time criticality (time available for system to compensate)
Effects vulnerability (disturbances will either be absorbed or propagate intra/extrasystemically)

Risk Analysis (Cost/Acceptability):
Probability of survival
Potential cost: in terms of men and equipment (attrition); sorties (opportunity cost); potential negative effects (collateral damage)

Final Decision (C & B Calculus/Merit/Suitability):
Effort must compete and be justifiable (versus other alternatives)
Merit of affecting system—degree of linkage to objectives (GS, S, OP, and TAC; [soundness of mechanism])
Cost-benefit calculus
Ability to measure and assess effectiveness of effort
Scrubbed for suitability versus constraints, restraints, and rules of engagement

Assessment (Effectiveness):
What are the strategic, operational, and tactical effects? (nature of influence, attrition, or virtual attrition)
Did it influence the adversary? (linkage to objectives)
Did it affect his strength, resistance, resolve, or upset his balance? (linkage to centers of gravity)
Persist or pursue other force-application efforts?

Appendix G

Summary Matrixes of Potential-Effect Relationships

Hostile ability		Hostile will
War making	**War sustaining**	**War will**
Force on force		Force on other
Forces	Forces and functions	Functions
Annihilation and attrition		**Attrition and virtual attrition**
Physical and systemic	Systemic and physical	Psychological and systemic
Material		Nonmaterial
Tactical level of war	**Operational level of war**	**Strategic level of war**
Close air support	INT	Strategic attack
Immediate effect	Intermediate effect	Long-term effect
First-order effect		**Second order + effects**
Direct effects		Indirect effects
Intended effects		Unintended effects
Simple systems		**Complex systems**
Intrasystemic		Exosystemic
Tightly coupled		Loosely coupled
Low-effects risk		**High-effects risk**
Low payoff		High payoff
Higher predictability		Lower predictability
Military	**Economic**	**Political and social**
Military		Government and people

Simple Systems	Complex Systems
Low interconnectivity and interaction	High interconnectivity and interaction
Basic structures	Intricate structures
Short cause-and-effect chains	Long cause-and-effect chains
High predictability	Low predictability
Straightforward effects	Perverse (complex) effects
Effects usually immediate	Effects often delayed
Proportionate effects (linearity)	Disproportionate effects (nonlinearity)
Effects additive	Effects greater or lesser than sum
Lesser chance of unintended consequences	Higher chance of unintended consequences
Outcomes usually match intentions	Outcomes do not necessarily match intentions
Isolated systems	Related systems